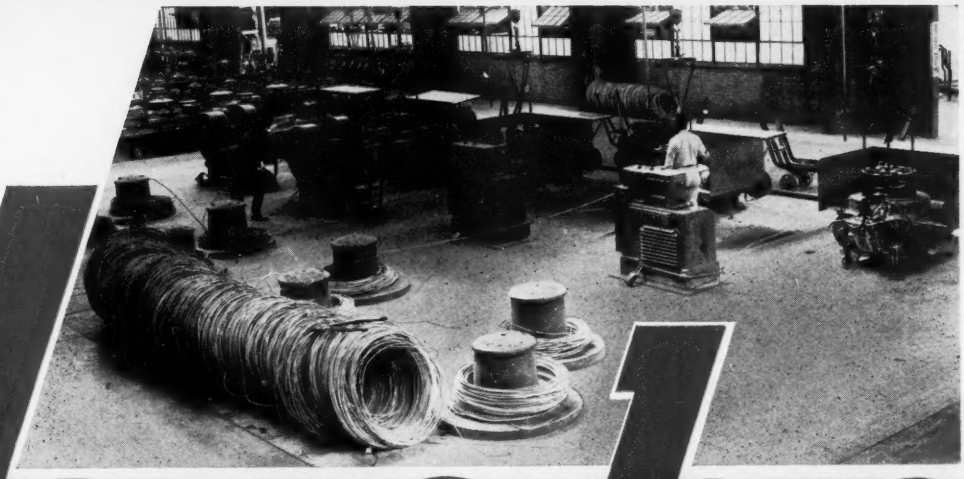
NOVEMBER 1938

WIRE AND WIRE PRODUCTS



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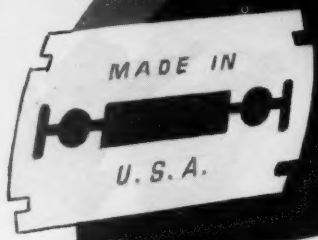

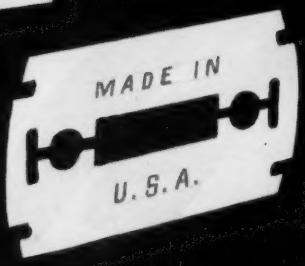

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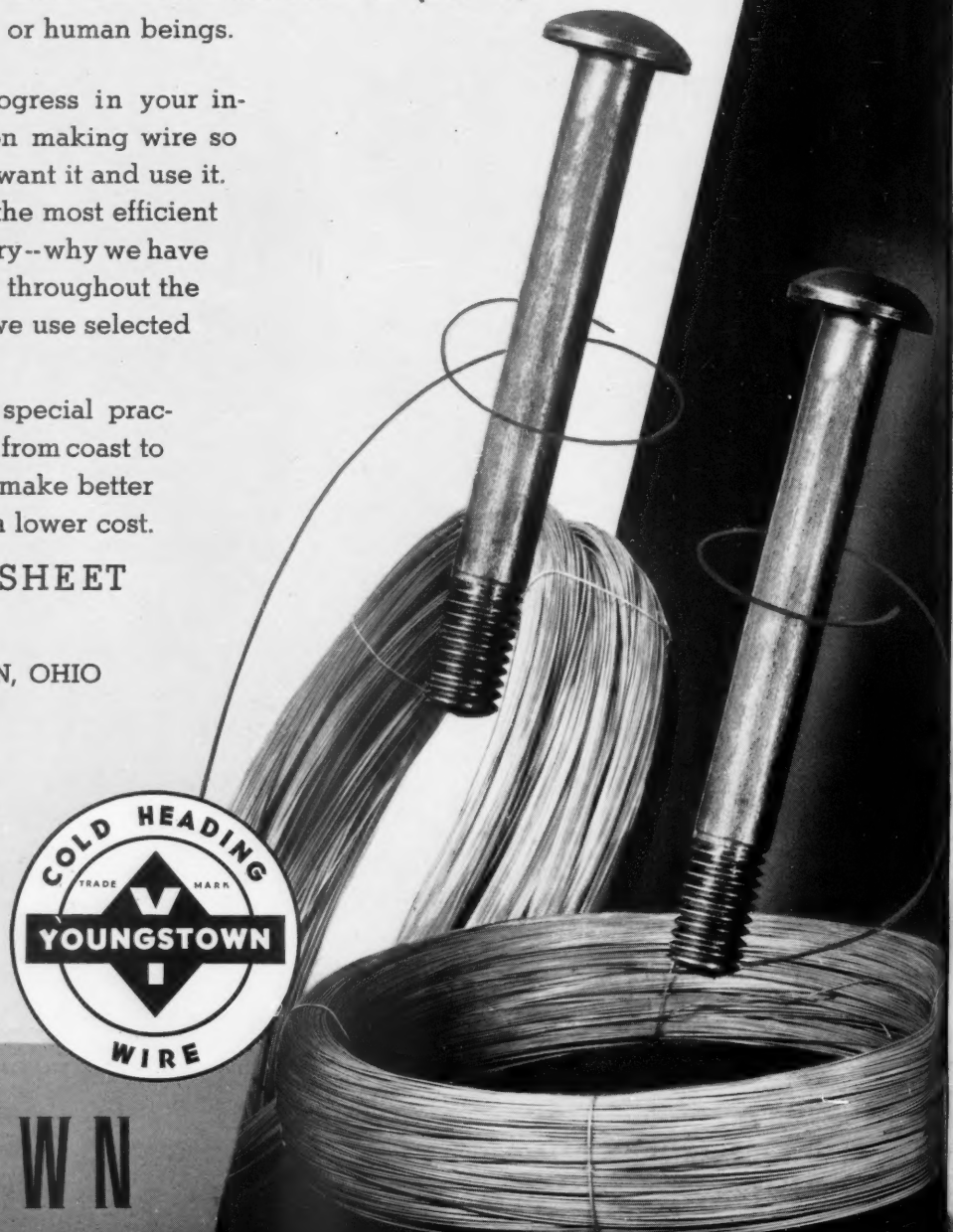

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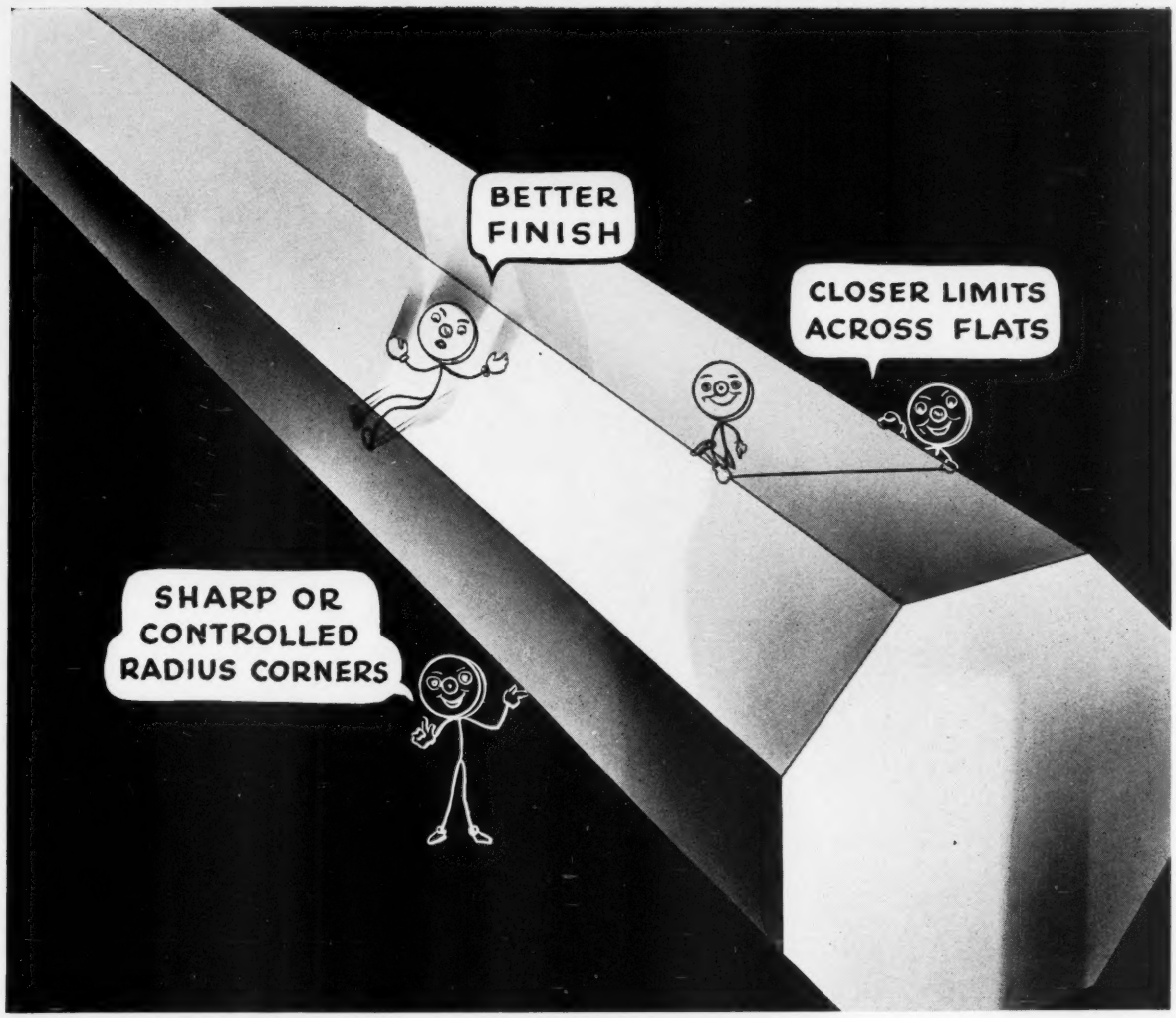

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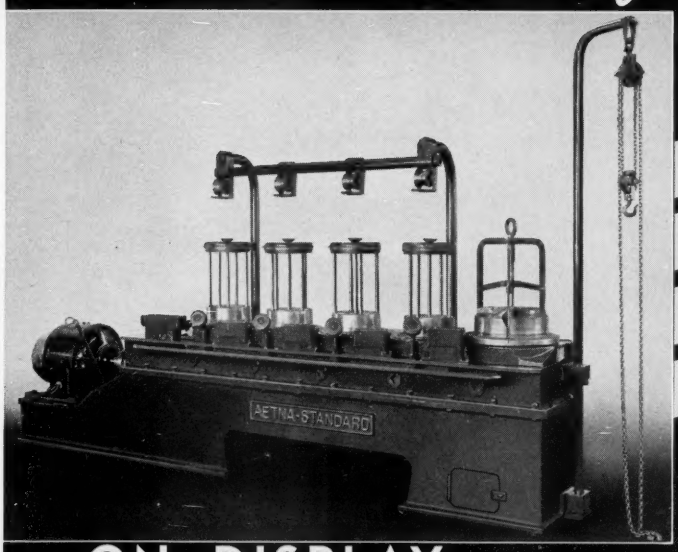

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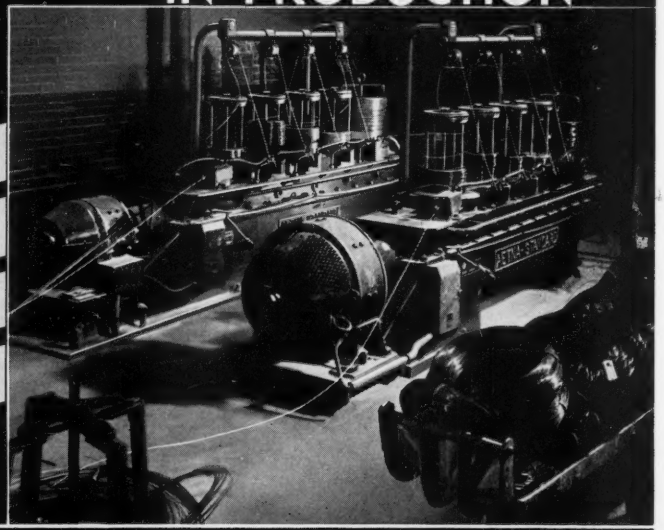

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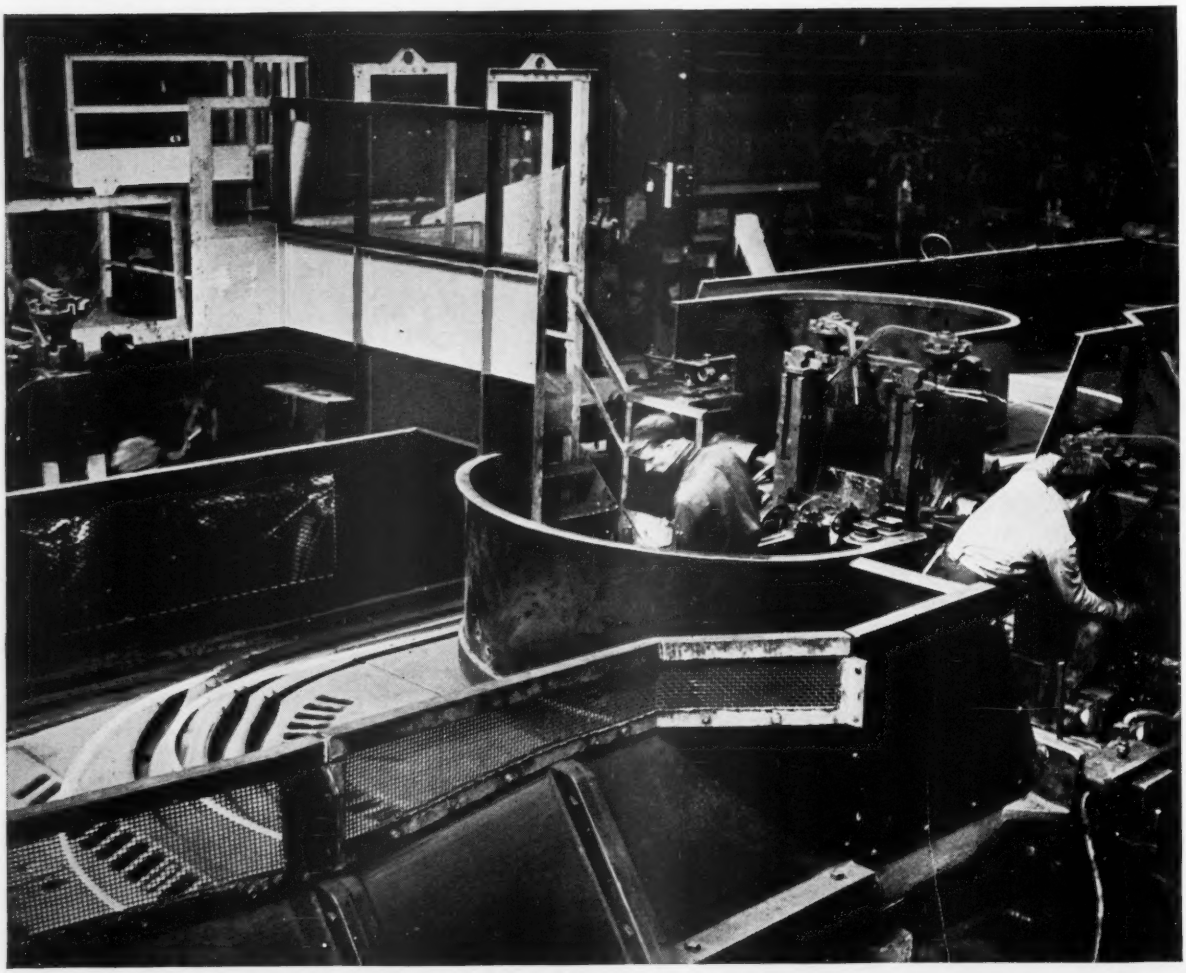

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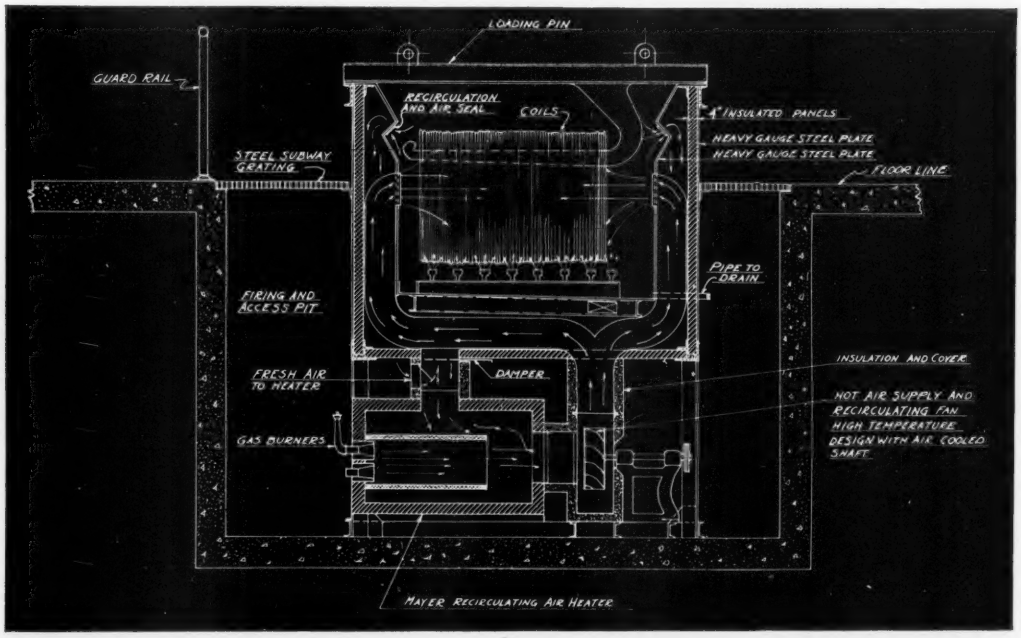

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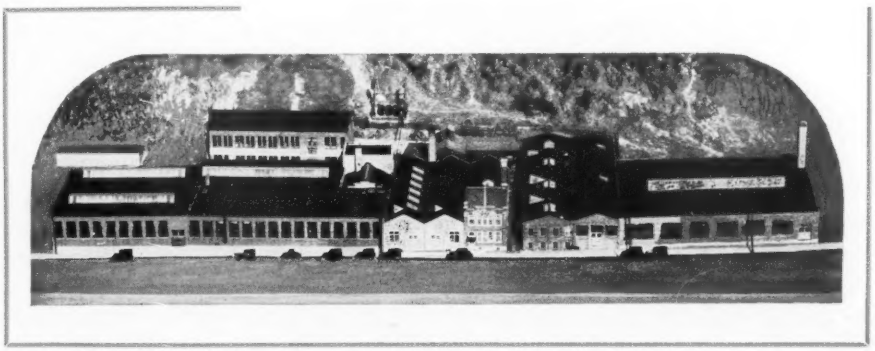

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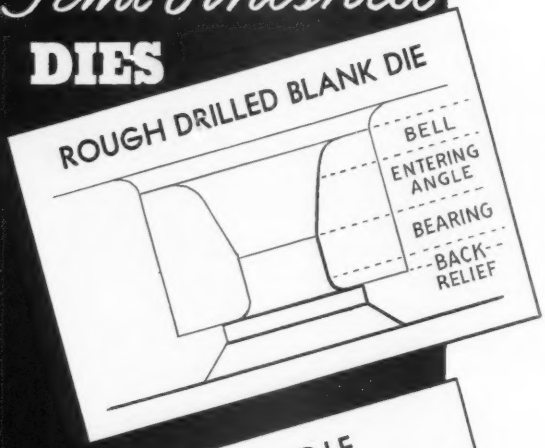

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WIRE AND WIRE PRODUCTS

A monthly publication devoted to the production of Wire, Rod and Strip, Wire and Rod Products and Insulated Wire and Cable

DRAWING—ROLLING—EXTRUDING—FORMING—FABRICATING

Vol. 13 NOVEMBER, 1938 No. 11

Designated as

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Contents

Fundamental Principles of Steel Wire Metallurgy ..... By B. L. McCarthy 655

The first of a series of three lectures delivered before the Wire Association, October, 1938.

The Development of High Strength Electrical Conductors and Messenger Cables ..... By C. H. Davis and Ira T. Hook 665

"Calsun Bronze" is the direct result of the experimental work of which a description is given in this paper.

The Annual Wire Association Convention 671-674-675-676

Assistant Secretary of War Addresses Wire Association 677

Industrial Mobilization ..... By Louis Johnson 678

Exports and Imports of Wire 679

A Review of Recent Wire Patents 683

'Round the World With the Wire Industry 685

Wire Stiffness Tester 689

Index to Advertisers 698

Where to Buy 698-699-700

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WIRE AND WIRE PRODUCTS

A monthly publication devoted to the production of Wire, Rod and Strip.
Wire Products and Insulated Wire and Cable.
DRAWING --- ROLLING--- EXTRUDING --- FORMING --- FABRICATING

Vol. 13 NOVEMBER, 1938 No. 11

Fundamental Principles of Steel Wire Metallurgy

By B. L. McCarthy,
Chief Metallurgist, Wickwire Spencer Steel Company,
Buffalo, N. Y.

FOREWORD

This is the first of a series of three lectures delivered before the Wire Association October, 1938.

In these lectures the author has attempted to present the fundamental principles of steel wire metallurgy in a manner which will make it understandable to the layman. At the same time, to present a complete picture, difficult subjects such as atomic forces had to be considered.

These lectures, therefore, are not simple to understand, but require some study. It is always difficult to arrive at a suitable balance between simplicity of presentation and thoroughness, for the two do not go hand in hand. We are all familiar with the simple facts of metallurgy and the behavior of steel but because of the lack of thoroughness in our knowledge of fundamental principles many of us are unable to employ the necessary logic in solving our problems.

It is hoped that these lectures will help to satisfy this need for fundamental knowledge and enable many of us, who are not very familiar with metallurgical principles, to more thoroughly understand our own problems and be better equipped to interpret the works of others directed towards the solution of kindred problems. ✦ ✦ ✦ ✦ ✦ ✦

PRINCIPLES

Atomic Forces

ABOUT the first thing one is taught in the study of chemistry is that **matter** is indestructable, and so it is, because it consists primarily of infinitely small, balanced, unit charges of electricity, called **atoms,** which exist in one form whether in the solid, liquid or gaseous state. Even though the substance before us may change in appearance, and a portion, or all of it, disappear as a gas, the Atoms of which it is composed, will continue to exist and remain the same, as far as individuality is concerned.

✦ ✦ ✦

THERE are two prime constituents of material substance, Elements and Chemical Compounds. An **element** is matter which is composed entirely of like atoms, and which cannot be subdivided into two or more different atoms. **Chemical compounds** are combinations of two or more dissimilar atoms held together by chemical attraction. Unlike Elements, Chemical Compounds can be subdivided into two or more different kinds of atoms.

✦ ✦ ✦

OFTEN, substances may be composed of two or more elements or chemical compounds or combinations of elements and compounds intimately mixed but not held together by any attractive forces. This is termed a **mechanical mixture.**

✦ ✦ ✦

THE balanced charge of electricity which forms the atom combines a **nucleus,** bearing a positive charge, with a varying number of **electrons** bearing negative charges, the sum total of which is sufficient to balance the positive charge of the nucleus. Atoms differ from each other, in the number of electrons surrounding the nucleus, the amount of negative charge contained in each, and in the amount of positive

charge contained in the nucleus. According to the last report of the International Committee on atomic weights (1936), there are 89 elements; this means 89 distinctively different atoms which, as far as has been determined, go to make up the world in which we live.

✦ ✦ ✦

A CONTINUOUS electrical exchange between the nucleus and electrons of the atoms, which takes the form of attractive and repulsive forces, hold the electrons in a definite relation to the nucleus. The intensity of this exchange varies with the temperature and at the same time, the space occupied by the atom, or the **atomic volume,** also varies. This variation in atomic volume accounts for the expansion and contraction observed when a metal is heated or cooled. Regardless of the velocity of exchange or the change in atomic volume however, the nucleus and electrons of an atom, because of the presence of these attractive and repulsive forces, remain in the same relation to each other.

✦ ✦ ✦

THE forces contained in atoms are not confined to the exchange between electrons and nuclei alone, but also take the form of attractions for other atoms, both similar and dissimilar; that is, there exist forces which cause atoms to seek combinations with other atoms. These forces hold atoms together or in combination with each other to form what is termed a **molecule.** A molecule differs from an atom in that it represents the smallest quantity of a substance existing in the free state. Atoms are constituents of molecules, they are held together in the molecule in definite proportions by chemical attraction.

✦ ✦ ✦

SODIUM Chloride represents a combination of atoms forming a chemical compound, and the molecule of Sodium Chloride contains one atom of Sodium and one of Chlorine; it is expressed by the chemical symbol NaCl. Other compounds may have atoms combined in different ratios; Sodium

BENJAMIN LEWIS McCARTHY

Born in Lockport, New York, in 1895. In 1913 was employed as Assistant Chemist by Simonds Saw & Steel Co. In 1916 was employed by Wickwire Steel Co., now known as Wickwire Spencer Steel Co., as Assistant Chief Chemist. Three years later was promoted to Chief Chemist and Metallurgist. Now in charge of the Chemical and Metallurgical Laboratories and directs research and special investigation into the Chemistry and Metallurgy of steel, steel wire and wire products. Member of the Wire Association, The American Society for Testing Materials and the American Society for Metals. Awarded the Wire Association Medal for the most meritorious paper on wire manufacture or fabrication during the year 1935, Certificate of Honorable Mention, 1936, the Medal Award for 1937.

Carbonate, for example, is composed of two atoms of Sodium, one of carbon, and three of oxygen; the molecule is expressed by the symbol Na_2CO_3. The power of combination between atoms is called **valency,** and the ratio of combination, or the number of other atoms with which a given atom will combine to form a molecule, is termed its **valence.** The forces holding them in combination are termed the forces of **primary valence.** These forces, like those which hold the electrons and nucleus in relation to one another in the atom, are both attractive and repulsive in nature. They represent an exchange between atoms. The atoms of all elements contain these forces which are continuously seeking relief, through the medium of balance, by combining with other atoms. The atoms of elements which, when in combination in the molecule, provide a suitable balance of the forces of primary valence, are considered combinations of maximum affinity or attraction. In the absence of atoms which will provide suitable balance, the atoms of a given element will combine with each other, or with atoms of another element which do not provide a suitable balance of these forces. When a molecule is made up of atoms of elements which do not provide a suitable balancing of the forces of primary valence, it can be broken up by coming in contact with atoms of an element which will provide a better balance. For example FeO (Iron Oxide) can be changed to Fe and Al_2O_3 by coming in contact with aluminum. This change is expressed by the chemical equation $3\ FeO + 2\ Al = 3\ Fe + Al_2O_3$. As is often the case in chemical reactions, a high degree of atomic activity is required to produce it. In this case the two materials must be heated to a high temperature before the above reaction can take place. This balancing of forces of primary valence constitutes the basis for all chemical reactions.

✦ ✦ ✦

IN the same manner as we have forces which combine atoms of different elements to form molecules, so also there is present in atoms forces which tend to hold them in a definite position or relation to each other in the solid state. These forces, which are responsible for crystallization, are termed forces of **secondary valence.** Here again the forces are repulsive and attractive in nature and tend to hold atom in a fixed position in the solid, by balancing with other surrounding atoms.

✦ ✦ ✦

WE now have before us three different forces of an atomic nature, the forces that hold the electrons of an atom in a fixed relation to the nucleus, the forces of primary valence which results in the formation of chemical combinations and the forces of secondary valence which hold the atoms in a fixed position in the solid. All matter depends for its existance in any fixed state on these forces and all changes or alterations which take place are influenced by them. This is not only true of chemical reactions in the laboratory but of all organic and inorganic changes. In the same

manner these forces, in an effort to seek relief through the medium of balance, form the basis for all changes which take place in metals, whether they be physical such as cold working; where the resistance is due to the forces of secondary valence resisting any change in atomic relations, which will upset their balance, chemical; wherein two or more metals combine to form a compound; or where, due to lessened atomic activity associated with the lowering of temperature, the atoms of one element separate from those of another, as will be shown later.

✦ ✦ ✦

WHEN, due to the application of heat, atomic activity becomes more intense, the forces of primary valence become more active and combination of atoms are formed more readily. This accounts for the acceleration of reaction which is always associated with the application of heat. At the same time combinations may exist between atoms at higher temperature, due to this accelerated activity, which are not stable at lower temperatures. These combinations are low in affinity and require a high degree of atomic activity for their existence. This accounts for the fact that two elements may be soluble in each other or have an attraction for each other at one temperature but separate at some lower temperature. This is an important fact to remember in connection with this study for it accounts for the precipitation that takes place in solid metal, a very important feature in developing physical properties in steel.

✦ ✦ ✦

AS the temperature is raised and we have an increased atomic activity, the forces of secondary valence because of a better balancing of forces, become less effective. This accounts for the increase in ductility in certain metals often associated with working at higher temperatures. As the temperature is further raised, these forces become ineffective to the point where they are not continuous and the bonds are easily broken; this provides a sluggish semi-solid state. On still further raising of the temperature, this weakening of effectiveness increases until only a partial bond exists; this is the liquid state. Further raising of the temperature so increases the atomic activity that the force of secondary valence are completely ineffective and we have the gaseous state.

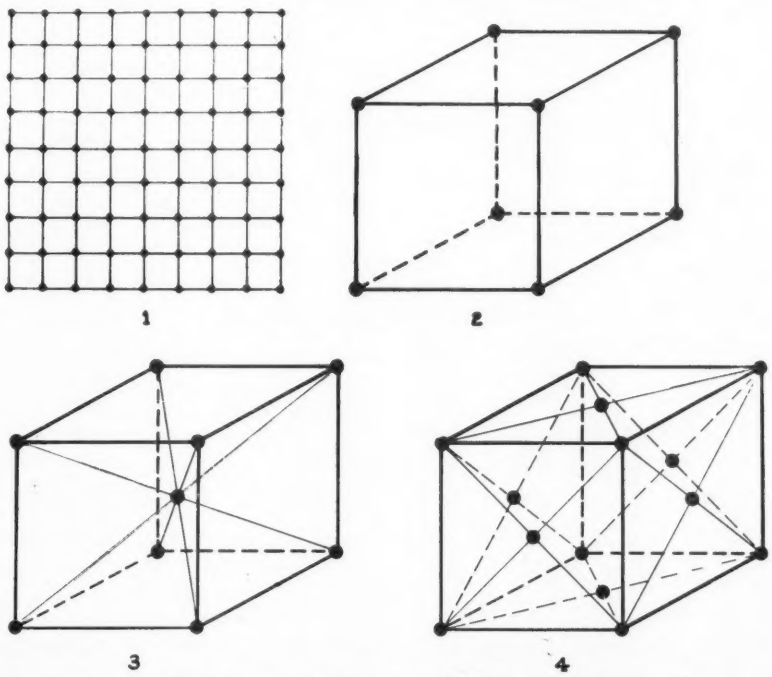


Figure A. Atomic Arrangement — Cubic Space Lattice.
1. Two Dimensional pattern showing lattice effect.
2. Simple cubic form.
3. Body centered cube.
4. Face centered cube.

✦ ✦ ✦

Crystallization

ALL metals and metallic alloys in the solid state are crystalline. This means that in this state the atoms of which metals are composed, are arranged in some definite geometrical pattern. In most metals, the atoms are arranged in such a manner as to form an outline of a cube, termed a **crystal unit** or **unit cell.** The crystallinity of metals is based on the presence of a large number of these cubes all held together by the forces of secondary valence. Crystal units may also be tetragonal or hexagonal, fortunately for us in connection with this study, the crystal units of Iron are cubic in shape, so we can confine our remarks to this form only.

✦ ✦ ✦

WHILE it is impossible for us to see these small crystal units, they make themselves apparent in numerous ways; for example, the crystalline fractures of metals often encountered. As in the case of the electrons surrounding the nucleus in the atomic structure, the atoms of a crystal unit are located in space with their attractive and repulsive forces holding them in place. A cross section of a cube would reveal this pattern to be similar to a lattice with the atoms at intersecting points (See Figure A-1). This of course is two dimensional, in a solid the atomic arrangement is similar to a three dimensional lattice work with the atoms at the corner of each square thus formed. The arrangement of the atoms in a metal is termed its **space lattice** because it represents definite positions in space.

✦ ✦ ✦

THERE are three types of cubic space Lattices; the simple form wherein we have only the atoms at each corner of the cube, the body centered space lattice which consists of eight atoms outlining the cube and one atom in the center and the face centered space

lattice wherein we have the eight corner atoms and one atom at the center of each of the six cube faces. In figures A-2-3-4 are shown the three cubic space lattices outlined.

✦ ✦ ✦

WHILE as stated previously, this arrangement of the atoms is not visible either by the naked eye or with the highest power of the microscope, yet their positions in the crystals have been definitely established by use of the X-Ray. These theories and principles therefore can be accepted as facts upon which to base our studies of the inner structure of metals.

✦ ✦ ✦

IRON can exist in both the face centered and body centered space lattice. It is this allotropy that plays a most important part in our heat treatment of steel. At relatively high temperatures pure Iron has the face centered cubic space lattice and in this form it is termed **Gamma Iron.** On cooling however, a temperature is reached in the neighborhood of 1600°F where a definite rearrangement of atoms takes place and the face centered arrangement gives way to the body centered, this is termed **Alpha Iron.** Other elements in combination with Iron may lower this temperature of transformation considerably.

✦ ✦ ✦

IT must be remembered that the crystals of Iron, as we see them, do not need to be cubic in shape to justify the above statements, the reason for this lies in the fact that when the metal solidifies crystallization begins at a number of points or nuclei throughout the molten liquid and proceeds by the addition of other crystal units which arrange themselves in relation to the original units. In this manner the crystals grow by the accumulation of unit cells, as the atoms cease the active movement associated with the liquid and become fixed in the solid. This growth around a common nucleus continues until a point is reached where it encounters resistance because of growth from other nuclei. Those units which are the result of

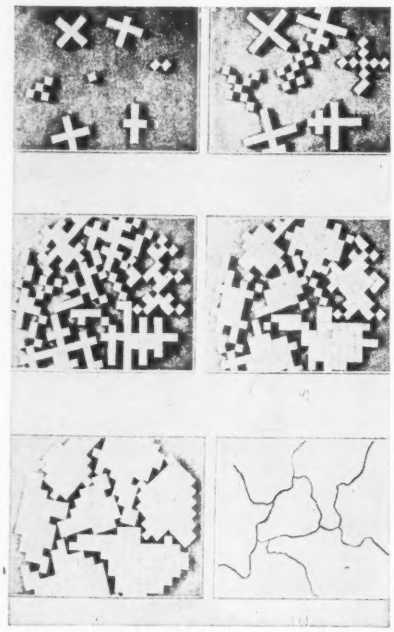


Figure B. (Rosenhain) Formation and growth of crystals from the liquid showing how the growth of a grain results from a building up of crystal units (white cube) around a common nucleus.

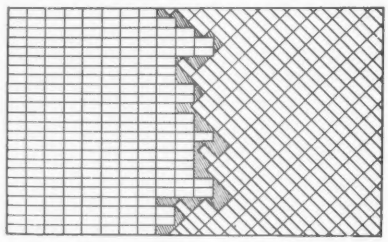


Figure C. (Rosenhain and Ewen) The formation of amorphous material at the grain boundaries. The rectangles representing crystal units of two grains. ✦ ✦ ✦ ✦ ✦

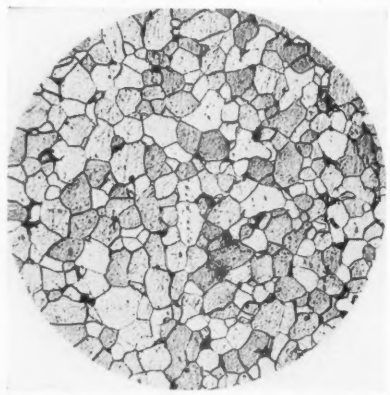


Figure 1. Etched with 2% Nital — 200 X. Grain orientation resulting from the attack of the etchant on the constituent Ferrite, the variations in coloring are influenced by the angle at which the cube faces of the crystal units intersect the plane of the specimen surface. ✦ ✦

growth from a common nucleus, form what is termed a **grain.** In figure B is shown the manner in which the grain is developed. The white squares are intended to represent crystal units. Note how the growth develops until finally a grain is formed. The material at the boundary of the grains which serves as boundary markings is non-crystalline and is said to be **amorphous.** The reason for this is that as the growth of the unit cells from a given nucleus encounters growth from other nuclei a point is finally reached where, due to lack of space, the remaining metal can not crystallize. In Figure C is shown, diagrammatically, the manner in which amorphous material is developed at the grain boundaries.

✦ ✦ ✦

BECAUSE of the definite spacing and arrangement of the atoms, all the cubes or crystal units which have developed from a given nucleus will have cube faces in the same plane. Inasmuch as crystallization starts from a large number of nuclei, each independent of the other, each grain will have its individual planes for the cube faces, see figure C, note the different plane for the cube face of the two grains portrayed. When a sample of steel is highly polished, followed by heavy etching it is possible to reveal this difference in planes between grains. This is shown by the way in which the light of the microscope is reflected and is termed grain orientation, see figure 1. This is a low carbon steel and the difference in shading between the various grains is due to the manner in which the planes of the cube faces intersect the plane of the specimen surface.

✦ ✦ ✦

Grain and Particles Growth

THE development of grains as shown in Figure B provides a balance for the forces of secondary valence because each atom in the center of the grain proper, is surrounded by other atoms, which tend to hold them in a balanced state. When crystallization is complete however, there exists, at the boundaries of the grains, atoms which by virtue of their position at the boundary are unbalanced because they are not completely surrounded by other atoms, but are being effected only by those which lie toward the

center of the grain. This unbalanced condition of the boundary atoms produces a force termed **surface tension.** Inasmuch as the size of the grains determines the amount of grain boundary material present, it follows that the smaller the grain size the greater will be the amount of unbalanced boundary atoms and the greater the surface tension forces. The only way in which these forces can be relieved, is by reducing the amount of grain boundary material through the medium of **grain growth,** that is, by the uniting of small grains to form large ones. This is accomplished when the amount of force present becomes great enough to overcome the rigidity of the metal and effect a rearrangement of the atomic structure which absorbs the amorphous material, at the grain boundaries, producing new grains larger in size. The addition of heat, which lowers the rigidity of the metal, is required to produce this change. When material is cold worked the forces of secondary valence are strained on heating the metal, however, a point is reached where a rearrangement of the atoms takes place which provides relief of strain. The temperature at which this occurs is more or less fixed for various metals and is called the **Recrystallization Temperature,** in Table I is shown the Recrystallization Temperatures of some of the more common metals.

✦ ✦ ✦

WHEN metals are worked above their recrystallization temperature, relief of strain is continuous. In the case of steel, working above 900°F produces continual relief of strain. This accounts for our ability to affect enormous reductions in hot rolling. Some metals, lead for example, because of a low recrystallization temperature can be worked at room temperature with continuous relief of strain. On further raising of the temperature further grain growth will result, time of course is required for this development. As will be discussed later the addition of alloys to iron which produce low-energy combination may influence grain growth and a degree of refinement may persist in one steel at a temperature at which another will have experienced considerable growth. Fine, non-metallic particles of a refractory nature may delay grain growth because of the obstruction they offer.

TABLE I
APPROXIMATE LOWEST RECRYSTALLIZATION TEMPERATURE

Metal	Temperature Degrees Fahrenheit	Metal	Temperature Degrees Fahrenheit
Iron	842	Magnesium	302
Nickel	1112	Tantalum	1832
Gold	392	Tungsten	2192
Silver	392	Molybdenum	1652
Copper	392	Zinc — Room Temperature	
Aluminum	302	Lead — Below Room Temperature	
Platinum	842	Tin — " " "	
		Cadmium — About Room "	

✦ ✦ ✦

WHEN precipitated particles of a metallic nature such as Iron-carbide are present in the metal, there is present at the particle boundaries amorphous material and unbalanced atoms and the same principles of growth, as a result of the forces of surface tension apply. In this case the growth is the result of fine particles combining or coalescing to form large ones. Irregular shaped precipitated particles, will tend to change to the rounded form when the temperature is raised and rigidity decreases because, by so doing, the total amount of boundary material is reduced.

✦ ✦ ✦

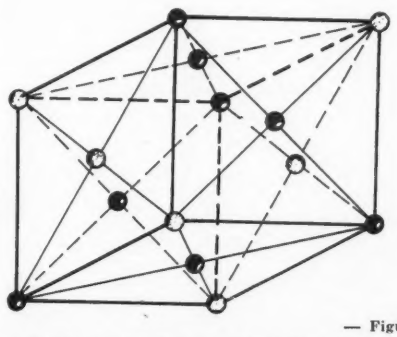
Alloying

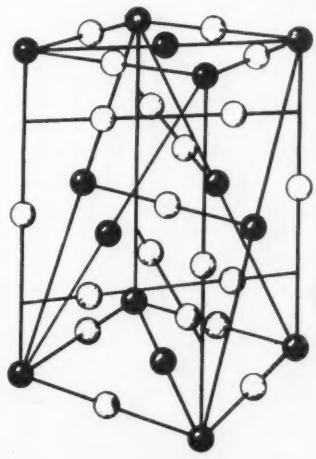
THE atoms which compose the crystal units may be all of the same element, or, they may be of two or more elements. If the first obtains, then we have a **pure metal** which requires no further description. If, however, the second case exists, we have two possibilities.

A — The atoms may be distributed over the space lattice in some irregular or variable amount, and be capable of replacing each other depending on the analysis of the metal. For example: We may have 8 atoms of Iron and 6 of nickel, or, if the nickel content is higher, we may have 4 of Iron and 10 of nickel. In this case we have what is termed a SOLID SOLUTION, that is, we have a solution in the solid form of one metal in another by virtue of their ability to replace each other in varying proportions over the space lattice. In figure D-1 is shown the arrangements of atoms of two different elements on the space lattice of a face centered cube.

✦ ✦ ✦

B — The atoms of the elements may be distributed over the space lattice in some fixed or invariable proportion to form some definite chemical compound. In this case we have what is termed an INTERMETALLIC COMPOUND. The combination of Iron and Carbon,





— Figure D —

1. Model of unit cell of a solid solution, showing irregular distribution of atoms of two elements over the space lattice. ✦ ✦ ✦

2. Model of unit cell of the intermetallic compound $TiAl_3$. White balls represent aluminum atoms, dark balls those of Titanium. (Fink & Van Horn) ✦ ✦ ✦ ✦ ✦

Fe_3C (Iron-Carbide), is an example of an Inter-Metallic Compound.

✦ ✦ ✦

INTER-METALLIC compounds usually have a complex atomic arrangement with numerous body centered atoms. As a result, they are much harder than solid solutions or pure metals which have a relatively simple atomic arrangement. In figure D-2 we have the cubic space lattice of an intermetallic compound.

✦ ✦ ✦

THE formation of a solid solution is based primarily, on the presence of chemical attractions, existing between the atoms of the different elements of which it is composed. Inasmuch as the raising of the temperature promotes atomic activity, and makes combinations possible which may not exist at lower temperatures, very often the lowering of the temperature will result in the precipitation of one or more element out of solution. This precipitation may start at one temperature and continue, as the solubility decreases, until a point is reached where it is completely precipitated. In the same manner, on heating metals which contain a precipitated constituent, a temperature is attained at which one constituent dissolves in another. This solution, the same as precipitation, will continue until a temperature at which complete solubility exists is attained above which we will have solid solubility.

✦ ✦ ✦

INTER-METALLIC compounds behave similar to pure metals regarding precipitation, and on reheating redissolve to form the solid solution. The control of the solution and precipitation of Iron-Carbide is the prime purpose of the heat treatment of steel.

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THE first principle of alloying demands that the elements of which the alloy is composed be soluble in each other at some temperature. Sometimes the solubility may persist to room temperature, again a point may be reached where, as shown above, one element or a combination of elements in the form of an inter-metallic compound may precipitate out and be present in the alloy as a mechanical mixture rather than by chemical attraction. Because of this, metals or metallic alloys may be composed of one or more of the following constituents.

PURE METALS
SOLID SOLUTIONS
INTERMETALLIC COMPOUNDS

✦ ✦ ✦

TWO metals may be soluble in the liquid state and insoluble in the solid state; lead and antimony are an example of this. Here we have an alloy composed of two pure metals. Again, one metal may be only partially soluble in the other; resulting in the combination of a solid solution and a pure metal. An intermetallic compound may precipitate out of a complex solid solution containing a number of elements, in which case we will have a solid solution consisting of a number of elements and a precipitated intermetallic compound. In steel, elements such as phosphorus, silicon, nickel, copper, etc., are completely soluble in Iron; Manganese, Chromium, Tungsten, etc., are soluble, but also form intermetallic compounds with carbon and a portion of them precipitate out as such. Carbon is soluble to a limited extent only and precipitates out in the form of the intermetallic compound, Iron-Carbide. This complex combination produces a wide variety of alloys in which we have complex solid solutions containing a number of elements, and complex precipitates of intermetallic compounds such as Iron-Manganese-Carbide, Chromium-Carbide, Tungsten-Carbide, and Iron-Carbide. It is by this means that the wide variety of alloy steels is developed. The basic principle of alloying remains the same, however, we have a solid solution made up of elements which will lend desired properties varying in ductility, and we have precipitated constituents, which, because of their hardness, promote strength, resistance to abrasion, and cutting properties.

✦ ✦ ✦

SOME steel may contain certain elements and be heat treated in such a manner as to prevent precipitation of any constituents. Some of the stainless steels are examples of this. The presence of Chromium and Nickel lowers the temperature at which the change from face centered to body centered cubic space lattice takes place, and, by sudden cooling from high temperatures, it is possible to retain Gamma Iron (Face centered cubes) at atmospheric temperatures.

✦ ✦ ✦

IN plain carbon steels wherein we have only Carbon, Manganese, Sulphur, Phosphorus and Silicon to consider, we have a solid solution of Manganese, Phosphorus and Silicon and precipitated Iron-Carbide containing a small amount of Iron-Manganese-Carbide. The sulphur in steel is present in the non-metallic form of Manganese-Sulphide. All steels should contain at least twice as much Manganese as Sulphur to insure the presence of enough Manganese to form Manganese-Sulphide with all the Sulphur present, thereby avoiding the presence of Iron-Sulphide which is very harmful to steel in connection with hot rolling.

✦ ✦ ✦

Equilibrium Diagrams

WHEN, as a result of heating or cooling, a definite change in the physical characteristics of a metal takes place which is accompanied by a rearrangement of the atoms, it is always associated with some measureable alteration in the behavior of the metal. The electrical conductivity undergoes a decided change—the expansion on heating or the contraction on cooling is abruptly altered, and it is accompanied by an absorption or evolution of heat. By employing one of these as an indicator, it is possible to record the temperature at which the change takes place. In this way Equilibrium Diagrams, representing a systematic accumulation of data, are developed, which serve as charts to indicate to the metallurgist the changes that take place when metals are heated or cooled. For the purpose of these lectures we will confine our thoughts to the thermal changes which occur on heating and cooling.

WHEN two metals are dissolved in each other, a definite lowering of the melting point of at least one of the metals results. The extent to which it is lowered depends on the composition of the alloy. There is, however, a combination in every case which will have a melting point lower than that of either metal. For example, we will take two metals M_1 and M_2, which are soluble in each other. M_1 melts at 1800°F while M_2 melts at 900°F. Any addition of M_2 to M_1 will result in the lowering of the melting point of the alloy to below 1800°F. Increased additions of M_2 will continue to lower the melting point until a point is reached where the melting point of the alloy is lower than that of the metal of lowest melting point M_2. Further additions of M_2 will again raise the melting point of the alloy until 900°F, which corresponds with the melting point of pure M_2, is reached. If, therefore, we were to prepare a series of alloys of varying compositions employing these two metals, heat them above 1800°F, place a thermocouple in the molten bath to indicate temperature, then allow them to cool, we would find, by plotting time against temperature that as the temperature falls, a point would be reached in each case at which the fall would be arrested temporarily and then continue. By plotting curves for the various compositions based on this break in the temperature drop we would be able to construct a diagram showing the freezing points of the various compositions of the M_1—M_2 system of alloys.

✦ ✦ ✦

IN figure E-1 is shown the manner in which data for the construction of an equilibrium diagram is obtained. The various compositions or alloys a, b, c, d, e, were all heated to above 1800°F, allowed to cool, and a time temperature curve plotted as the temperature fell. The points in the curves where the breaks occur indicate the point in the various compositions where the alloy became solid. Note how this solidification point varies with the various compositions from the alloy (a), which is high in M_1 to the alloy (e), which is rich in M_2; also that there is a point at composition (d) where the freezing temperature is lower than that of either parent metal. The composition which produces the lowest melting temperature is called the **Eutectic Composition** and the temperature at which it melts is called the **Eutectic Temperature.** By employing the data developed as shown in figure E-1 we are able to plot the Equilibrium Diagram shown in figure E-2. In the same manner, if we reverse the procedure and heat the metals to above 1800°F, we would find a corresponding break in the heating curve which would indicate the temperature at which the metal became liquid.

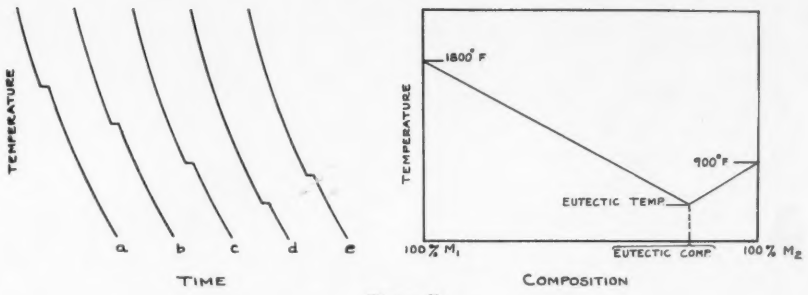

Figure E
CONSTRUCTION OF EQUILIBRIUM DIAGRAM
1—Accumulation of data from which diagram is constructed by a time temperature study. 2—Diagram constructed from data shown in No. 1. ✦ ✦ ✦ ✦

✦ ✦ ✦

WHILE the change in the rate of rise and fall in temperature, as indicated by our study of the M_1 and M_2 system of alloys, deals with the melting and freezing or solidifying points, changes of atomic arrangement which take place in solid metals will show a similar behavior. If, for example, two metals are soluble in each other at one temperature in the solid state, but insoluble at a lower temperature, the rearrangement of the atoms associated with the precipitation of the insoluble metal will show a similar break in the cooling curve. If the degree of solubility varies over a range in temperature, then we will get various readings for various compositions, and an equilibrium diagram similar to the one shown in figure E-2 can be constructed for changes which take place in the solid.

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THE word equilibrium is employed to indicate a diagram wherein the changes took place under conditions of equilibrium, that is the rate of heating or cooling, as the case may be, balanced with the time required for the

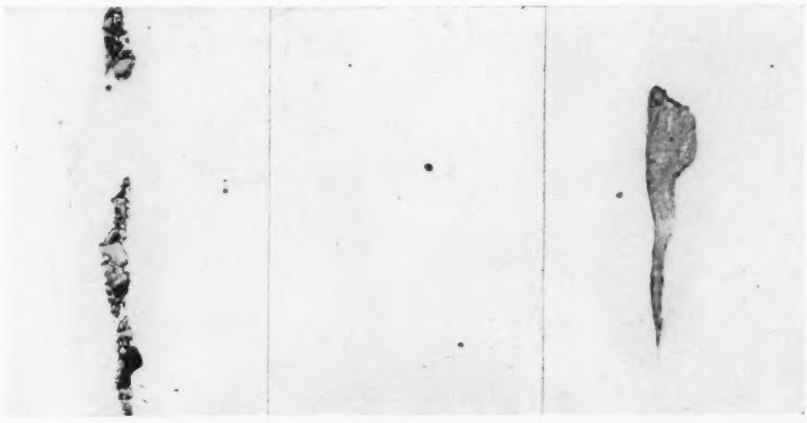

Figure 2
a Slag inclusion in Wrought Iron 200 X. ✦ ✦ b Iron Oxide 500 X. ✦ c Manganese Sulphide 500 X.

Fig. 3. .07 Carbon Steel 90 Grains per sq. inch at—100 X Etched with 2% Nital—100 X. ✦

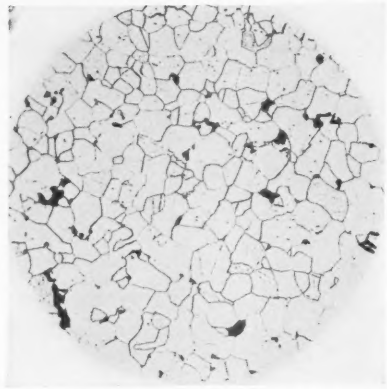

Fig. 4. Same steel as shown in Figure 3 Heat treated to enlarge the grains 12 grains per sq. inch at 100 X Etched with 2% Nital—100 X.

Fig. 5. Etched with 2% Nital 2000 X .65 Carbon Steel quenched and tempered. Fine particle size. ✦ ✦ ✦ ✦

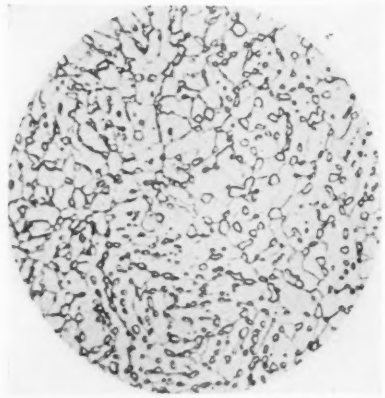

Fig. 6. Etched with 2% Nital—2000 X Spheroidized .65 Carbon Steel Large Globule of Cementite in a Ferrite Matrix. ✦ ✦

change to take place. If, on the contrary, the rate of heating or cooling is increased, the temperature at which the change takes place may be either higher on heating, or lower on cooling. The reason for this is that sufficient time is not allowed and the temperature of the metal may be higher or lower before the transformation takes place.

✦ ✦ ✦

THE Iron-Carbon Equilibrium diagram is of vital importance to our study of heat treatment, for it serves to show the temperatures at which the changes associated with heat treatment occur. Before going into this, however, it seems advisable to understand beforehand some of the principles of metallography.

✦ ✦ ✦

Metallography

IN order to understand metallurgy one must, of necessity, be somewhat familiar with **metallography,** the study of the microstructure of metals. In this study the microscope is employed and the sample to be examined is prepared by sawing or filing until a flat surface is obtained. This surface is further prepared by employing a careful polishing technique which eliminates all scratches. Unlike buffing, metallographic polishing consists of a cutting-away of the surface by the use of extremely fine abrasives.

✦ ✦ ✦

AFTER polishing is complete, the specimen may be examined directly, if non-metallic substances such as slag inclusions, iron or aluminum oxides, or manganese sulphides are to be studied, see figure 2—a, b and c. If, however, the grains are to be studied, or the size, shape and distribution of precipitated particles is sought, it is necessary to employ a suitable etching reagent to reveal them. The most common etchant is a weak solution (2%) of nitric acid in alcohol. Other etchants such as Picric Acid, Sodium Picrate, etc., also may be employed for special purposes.

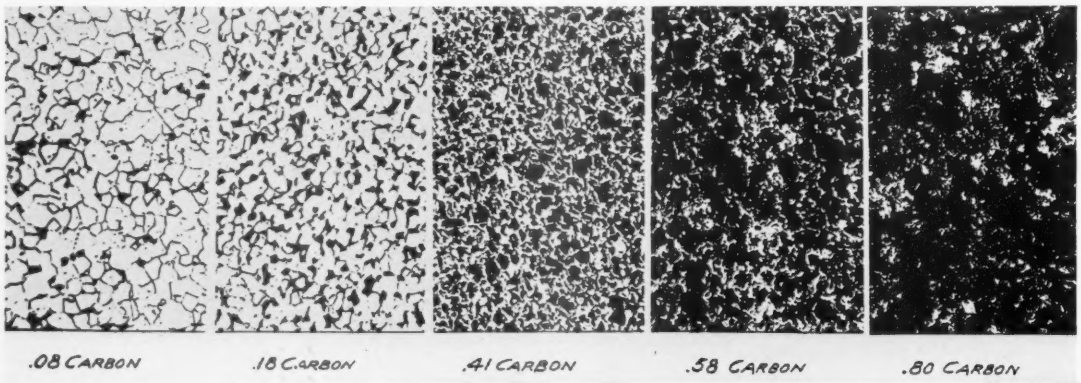

Figure 7
All Photomicrographs at 200 X
Influence of Carbon Content on the Amount of Free Ferrite and Pearlite Formed. Taken on No. 5 Rods in the as Rolled Condition. ✦ ✦ ✦ ✦ ✦ ✦

THE principles of etching are based on the preferred attack of the etchant upon area of greatest solubility. Because of the presence of unbalanced atoms and amorphous material at the grain and constituent boundaries, the atoms in these areas are free to enter into combination with the etchant, this promotes solubility and these areas are revealed first. The etching of metallographic specimens may be divided into two classes: **Boundary attack** and **constituent attack.** For most of our work in connection with the study of steel, we employ an extremely light etch to bring out the grain and constituent boundaries clearly. Over etching, or etching which has a definite attack on the constituents proper, usually is too heavy for the study of the grains or precipitated particles. The prime purpose of constituent attack is to show orientation. It was in this manner that the structure shown in Figure 1 was developed.

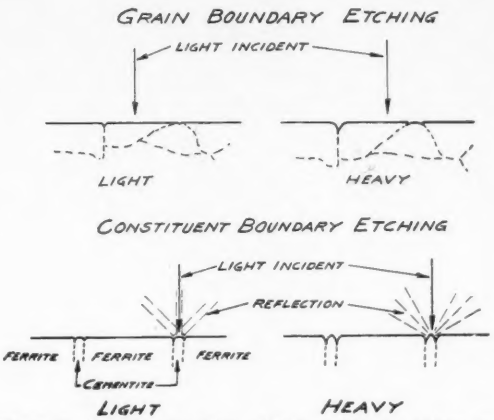

Figure F. Showing the effect of light and heavy etching on grain (upper) and constituent (lower) boundaries. Also the manner in which the light is reflected from the specimen.

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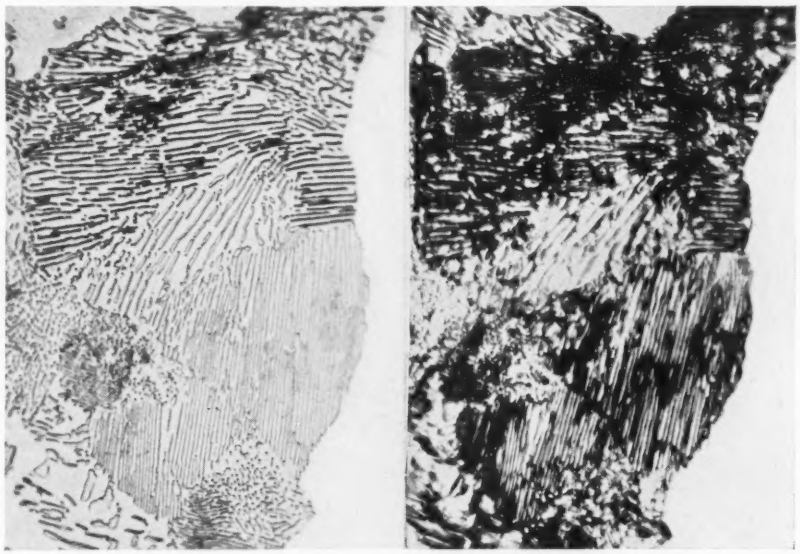
THE amount of black or white visible in the etched surface of a properly prepared specimen is a direct indication of the amount of boundary material present. For example, a large number of small grains will, because of the increase in boundary material, appear darker than a few large grains. This is shown between Figures 3 and 4. Figure 3 represents a low carbon steel which contains 90 grains per sq. inch when observed at 100 Magnifications while Figure 4 was taken from the same steel with 12 grains per sq. inch at the same magnification. The white areas represent carbon free iron, metallographically called **ferrite.** The presence of extremely fine particles of Iron-Carbide, metallographically called **cementite,** will for the same reason darken the specimen considerably as compared with a similar steel in which there are present large particles of Iron-Carbide. Here we have an increase in the amount of boundary material which lies between the two constituents Ferrite and Cementite. In Figure 5 and 6 we have two samples of steel of the same analysis. Figure 5 has extremely fine rounded particles of Iron-Carbide, while in Figure 6 the particle size is much larger; note how the increase in boundary material associated with fine particle size has caused 5 to darken as a result of etching. As the carbon content of steel is increased, the amount of precipitated Iron-Carbide will increase, and we have continued darkening of the specimen. In Figure 7 is shown the microstructure of steels of various carbon content taken from a hot rolled ¼" rod; note how the amount of dark material increases as the carbon increases. This is due to an increase in the amount of boundary material between Ferrite and Iron-Carbide.



a. Etched for 10 seconds 2% Nitric acid in alcohol

— FIGURE 8 —

b. Etched for 1½ Minutes 2% Nitric acid in alcohol

Showing the Manner in Which Over Etching Destroys Definition. Magnifications 2000 X.

✦ ✦ ✦

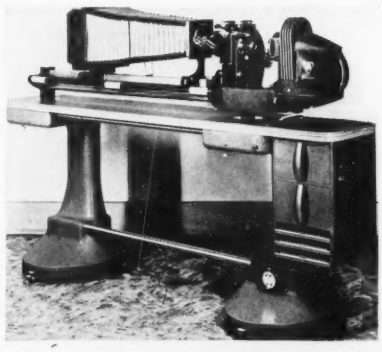


Figure G. Modern Research Metallographic Microscope and Camera.

✦ ✦ ✦

OVER-ETCHING will, by broadening out the boundary marking, make the sample appear darker under the microscope; at the same time, this extension of the boundary attack may be carried to the point at which fine particles are obscured completely.

✦ ✦ ✦

IT is very often true that, even with the lightest etching and employing the highest magnification, it is impossible to distinguish particles because of over-etching. In

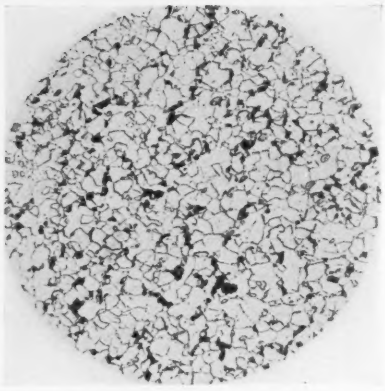


Figure 9. Low Carbon Steel Containing Pearlite (Dark Areas) taken at 100 Magnifications. ✦

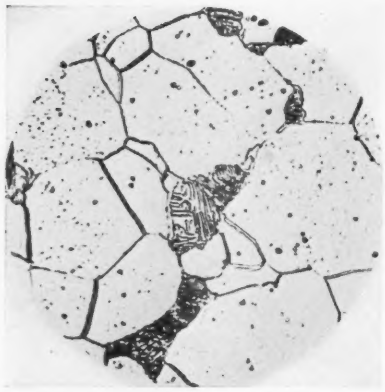


Figure 10. Same as Figure 9 only taken at 1000 Magnifications—Note the more complete resolution resulting from higher magnification. ✦

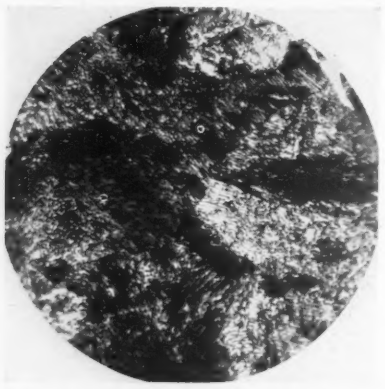


Figure 11. Medium Fine Pearlite Etched with 2% Nital 2000 X. ✦ ✦ ✦

Figure 12. Coarse Pearlite Etched with 2% Nital 1000 X. ✦ ✦ ✦ ✦

Figure F is shown, diagrammatically, the author's conception of the attack of the etchant on grain and constituent boundaries. In metallography the light is directed through the objective of the microscope and strikes the sample vertically or perpendicular to the specimen surface. If the surface is flat the light will be directed back into the microscope and the surface will appear white. If, however, because of small trenches formed on the surface of the specimen as a result of etching, the light is deflected, it will be lost, and these etched areas will appear dark. This illustrates the well known law; The angle of incidence is equal to the angle of reflection. The heavy etching shown in Figure F deepens and widens the microscopic trenches between both the grains and constituents, and, as shown, tends to round off the fine constituent particles until no flat surfaces remain which will reflect light back into the microscope. This makes the specimen appear dark. In Figure 8—a and b is shown the same structure after light and heavy etching.

✦ ✦ ✦

IRON-CARBIDE may be present in two distinct forms; it may be in the form of rounded particles called spheroidal or globular cementite and in the form of plates. The structure called **pearlite** consists of alternate plates of cementite and ferrite. See Figures 8, 10, 11 and 12. Other microstructures such as austenite, martensite and troostite will be encountered in the course of our studies and a complete description of them will be provided later.

✦ ✦ ✦

THE sample being studied under the microscope may be examined visually, or, by means of a suitable camera, be photographed. Photographs of micro-structures are commonly referred to as **photomicrographs.** In Figure G is shown a modern research **metallographic microscope** and camera.

✦ ✦ ✦

THE magnification used depends on that which we are seeking; if a general view of the structure, including a relatively large area of the surface, is desired, a lower magnification is employed, as, for example, in grain size studies—see Figures 3 and 4. If, however, complete resolution of the structure is sought, higher magnifications are required. In Figure 9 we have a sample of low carbon steel taken at 100 X. Note the dark areas, with higher magnification (shown in Figure 10) we have more complete resolution and find that these dark areas are composed of alternate plates of ferrite and cementite and we have the structure called **pearlite.**

✦ ✦ ✦

THERE has been considerable controversy as to whether or not the black lines in pearlite were ferrite or cementite. Applying the principles of etching outlined, and by referring to Figure F, it can be seen readily that the dark areas represent extremely fine plates of cementite, which, because of their thinness and the attack of the etchant, present no flat surface to reflect light into the microscope. Therefore, the black lines are the result of attack on constituent boundary. Both ferrite and cementite show white under the microscope. The thickness of the cementite plates in the structures of pearlite may vary widely. If the plates are thin, the structure will be darkened considerably, if, on the other hand, extremely thick plates of cementite obtain, it is possible, by means of light etching and high magnification, to bring out the constituent boundary and have the cementite plates appear white. In Figure 11 is shown a structure of relatively fine pearlite. Figure 12 shows another structure of pearlite in which we have a coarse plate thickness. The fact that Figure 12 was taken at 1000 X while Figure 11 was taken at 2000 X demonstrates how widely the thickness of the cementite plates may vary.

The Development of High-Strength Electrical Conductors and Messenger Cables

By C. H. Davis and Ira T. Hook,
Asst. Technical Manager, Research Engineer,
The American Brass Company, Waterbury, Connecticut

The development of the high strength electrical conductor and messenger cable to its present point of efficiency is a direct result of the experiments described in this paper. "Calsun bronze" is a direct result of the experimental work of which a description is given. A paper presented before The Wire Association at Detroit, Michigan, October, 1938.

WITH the advent of electric street railways, a single hard-drawn copper wire about ½" diameter was employed for the overhead system. For many years there was no thought of change except in increasing the strength and purity of the copper itself. Experience revealed, however, that the wire had a shortened life in the center of cities and on important curves where the wear and service are maximum. The New Haven Railroad sought a high-strength, contact wire for its electrification. Under these newer conditions the conductivity of the wire became lesser in importance and values down to 30% I.A.C.S. were found satisfactory for certain locations.

✦ ✦ ✦

FOR these higher strengths, the tin bronzes were first offered and these, in some sizes, had a tensile strength of 80,000 pounds per square inch and better. Wires of this nature were more or less special and there were no standard requirements.

✦ ✦ ✦

THE early years of the Twentieth Century brought intensive study of the characteristics of the copper-base alloys. Among other endeavors in this field, the late W. H. Bassett introduced into this country in 1910 from Italy the alloying of cadmium with copper. This element acted not only as a hardening and strengthening agent for the copper but also as a deoxidizer, thus avoiding phosphorus and its effect on conductivity. Copper with 0.8 to 1.0% cadmium was found to have 80 to 85% conductivity and physical properties equal to those of the tin bronzes then in more common use. While cadmium bronzes and tin bronzes in grades of equal strength have equal resistance to mechanical wear, the cadmium bronzes, because of their higher conductivity resist to a greater degree combined mechanical and electrical wear. Other advantages are the increase in current-carrying capacity or decrease in power loss and voltage drop.

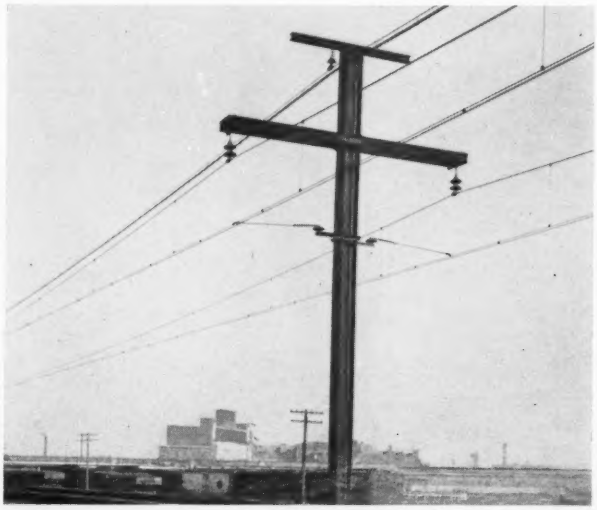


Fig. 1. H-column support of two messengers and contact wires. ✦

✦ ✦ ✦

INVESTIGATION of several other rich copper alloys for high-strength conductors was cut short by war demands, 1914 and later. Even the manufacture of the cadmium alloys was not resumed in volume until about 1922 when orders up to twenty miles were filled. Failure to produce more rapidly was due chiefly to lack of special equipment rather than lack of demand.

✦ ✦ ✦

SPECIFICATIONS for trolley wire first resulted from the interest on the part of trolley roads and elevated railways. The growth of these specifications may be traced since 1916 in the Proceedings of the American Society for Testing Materials. (Table I)

✦ ✦ ✦

AS the speeds of the electric railways increased the single-wire system was no longer satisfactory. It sagged too much at midspan and had too sharp a bend at the clamp. Hence a suspending or "messenger" cable was needed to support the contact wire at a uniform elevation above the tracks.

✦ ✦ ✦

THUS, a continuation of the investigation to discover alloys of high strength and moderate conductivity was begun in

the early Twenties. The effect of aluminum and silicon on the tin bronzes was the subject of a special study by **W. H. Bassett, Jr.**, and one of the authors. This resulted in the new alloy of copper, aluminum, and tin* (Calsun Bronze)† the characteristics of which are given in detail in the following pages. A further improvement was secured by the addition of silicon in amount about 1.0%.

✦ ✦ ✦

DURING this latter period came the early development of the precipitation-hardening, copper-base alloys such as chromium-copper, nickel-silicon-copper alloys, Beryllium Copper and variations of these. At present these heat-hardenable alloys are not displacing the cadmium and tin bronzes to any extent but their field of usefulness is broadening.

✦ ✦ ✦

Calsun Bronze

A HIGH-STRENGTH alloy was sought which would be more resistant to corrosion than the wire and cable then available in 1924. The weight-carrying member, the "messenger cable" of overhead electrical construction, is subjected to conditions of service more severe than those on almost any other member used in engineering construction. A comparison of the gossamer-like, messenger cables to the supporting steel, Fig. 1, brings out this contrast. The steel is not only comparatively massive in its proportions but is carefully protected by paint.

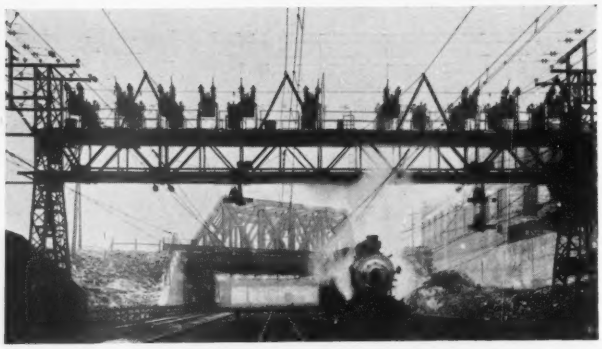


Fig. 2. N. Y., N. H. & H. electrification. Note combination of steam and smoke pouring into overhead construction.

✦ ✦ ✦

THE messenger cable, while exposed to wind and weather without protection and loaded to an unusually high value with an uncommonly low factor of safety, is nevertheless subjected to a corrosive atmosphere made still more severe by the smoke and condensation from an occasional steam locomotive. The sulphurous acid arising from locomotive smoke and steam, Fig. 2, will very quickly eat through a ferrous wire or cable, making the use of a copper alloy imperative. Needless to say, a messenger cable must perform faithfully for an indeterminate period of years without appreciable deterioration. There follows a summary of the development of the messenger cable alloy "Calsun Bronze".

✦ ✦ ✦

AMONG all the elements considered as strengtheners and deoxidizers of copper, aluminum and silicon stood out as the most promising, in spite of the fact that certain English authorities had frowned upon attempts to combine the three elements.

✦ ✦ ✦

IN order to investigate thoroughly the effect of aluminum and silicon on the tin bronzes, a set of sixteen different compositions were cast and processed into wire at 0.162″, 0.128″ and 0.102″ diameters. The compositions were varied as shown in Table 1A.

✦ ✦ ✦

THE usual method of making wire is to cast a bar of convenient size and weight, hot roll it to a round rod of ¼″ to ⅜″ diameter, and then cold draw to the finished size. No difficulty was experienced in securing sound castings with any of these alloys. Observations on the hot rolling of these alloys enabled one to draw the following conclusions:

(1) The copper-tin bronzes carrying up to 3% of tin showed a greater tendency

*Patent No. 1,630,999
†Trade Mark

TABLE I
CHANGES IN A. S. T. M. SPECIFICATIONS FOR BRONZE TROLLEY WIRE
Years 1916-1938 Illustrated by Example in 0.365″ Diameter

Years	High-Strength Bronze Wire		Medium-Strength Bronze Wire			
	Tensile Strength Lb. Per Sq. In.	Elongation In 10″, Percent	Tensile Strength Lb. Per Sq. In.	Elongation In 10″, Percent	Tensile Strength PSI	Elongation In 10″, Percent
1916-1924	71,700	2.50	61,600	2.50		
1925-1926	79,000	2.80	66,000	2.80		
1927-1935	73,000	2.75	65,000	2.75		
	Class A Bronze Wire (Formerly 40%)		Class B Bronze Wire (Formerly 65%)		Class C Bronze Wire (80%)	
1935-1938	73,000	2.75	65,000	2.75	69,000	2.75

to crack in the hot rolls than either the straight aluminum-copper or the straight silicon-copper.

(2) Increasing amounts of aluminum up to 3% added to copper increase the suitability of the resulting alloy to hot rolling. Previous experience in handling aluminum bronzes, as the alloys of copper carrying 1% to 10% of aluminum are called, supports this conclusion—the 5% aluminum, 95% copper alloy being well known as an exceptionally good hot forging bronze.

(3) Amounts of silicon up to 3% added to copper do not seriously impair the adaptability of the alloy to hot rolling. The temperature range of hot workability of the 3% silicon-copper alloy is narrower than that of the 3% aluminum-copper alloy.

(4) With the tin, as in this case, standardized at approximately 1.8% and aluminum added in amounts up to 3%, no difficulty was encountered in the hot rolling. This was probably due in part to the thorough deoxidation of the tin and in part to the excellent hot forging properties of the aluminum-copper solution.

(5) Similarly, with the tin at approximately 1.8% and silicon added in amounts up to 2%, no difficulty was experienced in the hot rolling. With 3% of silicon added, there was a tendency to crack, though with the heat correct, it could be successfully rolled.

(6) The special bar No. 16, in which the tin was reenforced with 1% each of aluminum and silicon, was hot rolled without difficulty.

✦ ✦ ✦

THE above group of hot rolled rods were cold drawn from approximately 0.315″ diameter to 0.162″, 0.128″ and 0.102″ diameters, equalling reductions of 74, 84 and 90% respectively. The wires were then tested for tensile strength, elongation, conductivity and flatback with the following results. The tests are too few and do not take into account the variations encountered in commercial practice so that they cannot be taken as exact values for the given composition. They do, however, show decided **trends** for both alloying elements and extent of cold reduction. The electrical conductivity is affected greatly by the alloying element and to a lesser extent by the cold work in the wire. In this case all of the conductivity readings were taken on the .128″ diameter wire which had 84% reduction in the wire dies. The results were averages of two or more tests.

✦ ✦ ✦

A STUDY of the action of the various alloys and the results obtained from the wires brings out the following points:

(1) Copper alone can be expected to develop not more than approximately 66,000 lbs. per sq. inch.

(2) Tin alloyed alone with copper is unsatisfactory for messenger cable strand although the tabulation shows a consistent increase in strength with increasing amounts of tin up to 3%. However, difficulty was encountered in both the hot rolling and the cold drawing with the 3% tin alloy.

(3) The aulminum-copper alloy and the silicon-copper alloy show a consistent gain in strength, the latter having a faster rate of gain in strength but with a considerable sacrifice in electrical conductivity.

(4) With the tin bronze deoxidized and strengthened with either aluminum or silicon, a very satisfactory strength is attained, the addition of 2% of silicon being approximately equivalent in point of strength and ductility developed to 3% aluminum. The 2% silicon-tin bronze, however, has only about half the electrical conductivity of the 3% aluminum-tin bronze.

(5) With the tin bronze deoxidized and hardened with 3% of silicon, difficulty is experienced in both the hot rolling and cold drawing. The limit of ductility has been exceeded and the electrical conductivity is less than half that of steel. The 3% silicon-tin alloy is there-

VARIATION OF COMPOSITIONS FOR TEST PURPOSES
TABLE 1A

Group	Bar	Copper %	Aluminum %	Tin %	Silicon %
1	1	Rem.	....	1*	....
	2	Rem.	....	2*	....
	3	Rem.		3*	
2	4	Rem.	1	....	....
	5	Rem.	2	....	....
	6	Rem.	3	....	....
3	7	Rem.	....	....	1
	8	Rem.	....	....	2
	9	Rem.		....	3
4	10	Rem.	1	1.8	....
	11	Rem.	2	1.8	....
	12	Rem.	3	1.8	
5	13	Rem.	....	1.8	1
	14	Rem.	....	1.8	2
	15	Rem.		1.8	3
6	16	Rem.	1	1.8	1

*=Deoxidized with phosphorus, .002% remaining in the alloy. ✦ ✦

Fig. 3. Calsun Bronze cable (parallel to and above I-beam) loaded to 52 per cent of its breaking strain by means of dead weights on a bell-crank lever. Note extensometer wire with measuring cylinder and cable holder. ✦ ✦

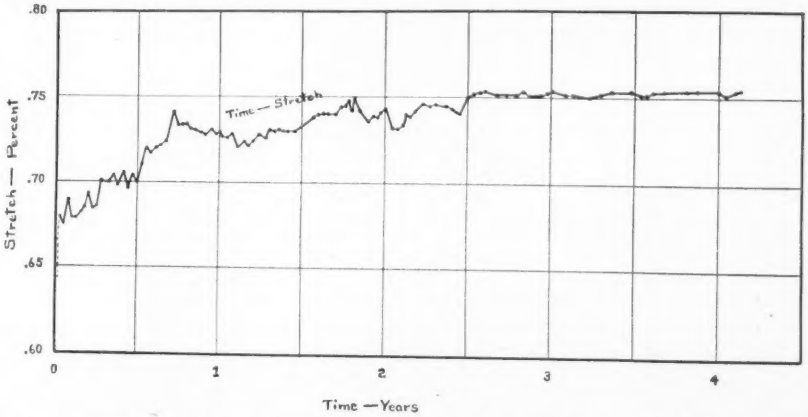


Fig. 4. Sustained load test on Calsun Bronze cable. Load equalled 52 per cent of cable strength. Cable data:

7 wires. Avg. diam. inch	.1026
Gauge length, feet	25
Johnson's Elastic Limit	95,000 lb. per sq. in.
Breaking Strain, lbs.	8363
Tensile Strength	144,500 lb. per sq. in.

RESULTS OF TESTS OBTAINED FROM WIRES OF VARIOUS ALLOYS

Composition Percent				Electrical Conductivity IACS % at 20°C.	Properties of Cold Drawn Wire					
					Tensile Strength lbs. per sq. in. at diameter of			Elongation in 60", % at diameter of		
Copper	Tin	Aluminum	Silicon		.162"	.128"	.102"	.162"	.128"	.102"
100	....	....	....	98	64,100	65,400	66,200	1.32	1.33	1.10
Rem.	1	....	....	51	74,400	76,900	80,100	0.98	0.86	0.90
Rem.	2	....	....	35	85,600	89,300	90,100	0.94	0.86	0.71
Rem.	3	....	....	21	*	98,400	98,700	*	0.88	0.77
Rem.	....	1	....	37	67,200	69,000	71,500	1.11	0.96	0.92
Rem.	....	2	....	24	82,500	88,500	92,000	1.86	1.34	1.40
Rem.	....	3	....	19	103,500	111,700	116,000	2.42	2.23	1.69
Rem.	....	....	1	17	76,600	81,700	84,300	1.34	1.25	0.98
Rem.	....	....	2	10	112,000	122,000	130,000	2.73	2.13	1.83
Rem.	....	....	3	7	128,400	139,600	146,000	2.76	2.50	1.88
Rem.	1.8	1	....	24	93,000	98,400	110,400	1.05	1.05	1.19
Rem.	1.8	2	....	18	113,000	123,000	133,000	2.11	1.79	1.42
Rem.	1.8	3	....	15	132,000	145,000	152,000	1.79	1.86	1.63
Rem.	1.8	....	1	14	105,000	119,000	130,000	1.15	1.44	1.44
Rem.	1.8	....	2	8	139,000	141,000	156,000	2.02	1.65	1.63
Rem.	1.8	....	3	6	150,000	*	*	1.96	*	*
Rem.	1.8	1	1	12	127,000	138,000	146,000	1.90	1.96	1.65

*=Wire too hard for commercial reductions—frequent breaks in dies.

fore out of the question as a messenger bronze.

(6) Tin alone added to copper increases the strength and hardness at a sacrifice of the ductility.

✦ ✦ ✦

THE use of aluminum up to 3%, or silicon up to 2%, as a deoxidizer and strengthening element is accompanied by a gain in the ductility as measured by the elongation. This conclusion is supported by the flatback test which was satisfactory in every case except that of the 3% tin-copper alloy and the 3% silicon-tin-copper alloy which failed to make a 180° bend in all three sizes of wire. The 3% aluminum-tin-copper alloy met the flatback test without difficulty in all wires.

✦ ✦ ✦

BY reason, therefore, of the excellent qualities obtainable with the copper-tin-aluminum combination, a composition of approximately 1¾% tin and 2½% aluminum dissolved in 95¾% copper was selected and named for convenience "Calsun Bronze". The hardening and deoxidizing elements may be varied slightly in order to secure the strength and ductility desired.

✦ ✦ ✦

Corrosion Resistance

THE mechanical and electrical properties of conductor wire and cable may not in themselves fit the material for use in the highly corrosive conditions that exist along partially electrified steam railroads, in tunnels, in salty fogs along the seashore and in smoky industrial centers. Although laboratory accelerated spray tests are open to some criticism, nevertheless they are usually comparative when run under identical conditions. A study was made covering a year during which conductor alloy wires not under stress were subjected to 20% salt spray, and similar wires to sulphur dioxide plus moisture spray. The conclusion of the report for the year reads:

"As judged by the loss in weight and breaking strain before and after corrosion, the Calsun Bronze shows only slightly less resistance to corrosion than copper. It is appreciably more resistant than the tin-bronze or the tin-silicon-bronze. The elongation shows a somewhat lower value after corrosion but a careful examination showed no evidence of pitting."

✦ ✦ ✦

THE tensile strength of the Calsun Bronze in both spray tests dropped only from 141,000 to 139,000 pounds per square inch.

✦ ✦ ✦

AN atmospheric corrosion test on a stress-free coil of Calsun Bronze suspended in an industrial atmosphere eight feet above the water surface of a canal showed no loss in strength in 5½ years. The results are given in the table below.

✦ ✦ ✦

CALSUN Bronze ⅜" cable stranded of 0.1243" diameter wires was exposed in the "Hemphill Tunnell" test of the A.A.R. Electrical Section* and was pronounced "excellent" in appearance after five years' exposure. A similar cable was exposed three years in the smoke jack at Cedar Hill (New Haven) and was pronounced "good" by the Committee of the A.R.A. in their 1934 report† on **"The Relative Corrosion of Fer-**

ATMOSPHERIC CORROSION TEST ON A STRESS FREE COIL OF CALSUN BRONZE

	Original Wire	After 5 Yrs., 8 Mos. Exposure
Diameter Inch	0.1013	0.1014
Breaking Strain, Lbs.	1207	1208
Tensile Strength, Lbs. Per Sq. In.	149,930	149,530
Elongation in 2" %	2.5	1.7

rous and Non-Ferrous Alloys in Smoky Atmospheres."

✦ ✦ ✦

THERE is a certain class of materials which, while showing excellent resistance to corrosion when stress-free, exhibits a marked loss of strength due to pitting or cracking when corroded under stress. Three tests were made on Calsun Bronze wire to cover such a condition. The first two were on single wires under strain, while the third was an extended test on a complete Calsun Bronze cable.

✦ ✦ ✦

Corrosion and Tension

A CLOSED loop was made in a single wire of Calsun Bronze and loaded to 33% of its tensile strength. It was exposed to the weather in a particularly bad industrial atmosphere where the air was continually tainted with sulphuric acid fumes. It remained in this atmosphere under strain for three years, eleven months. Tests made before and after the sustained load-corrosion test are shown in the table below.

✦ ✦ ✦

THE wire not only showed no deterioration but, if anything, an improvement. The corrosive atmosphere had not affected the wire beyond developing a thin black patina on the surface which could be readily rubbed off with an abrasive while the strength had actually increased due to equalization of locked-up stress.

TESTS MADE BEFORE AND AFTER THE SUSTAINED LOAD-CORROSION TEST ON CALSUN BRONZE WIRE

	Before Exposure	After 3-11/12 Years Under Strain in Weather
Diameter, Inch	.1014	.1019
Breaking Strain, Lbs.	1175	1205
Tensile Strength, Lbs. Per Sq. Inch	145,430	147,600
Elongation in 10" %	.57	.51
Fracture	In gauge length	In jaw

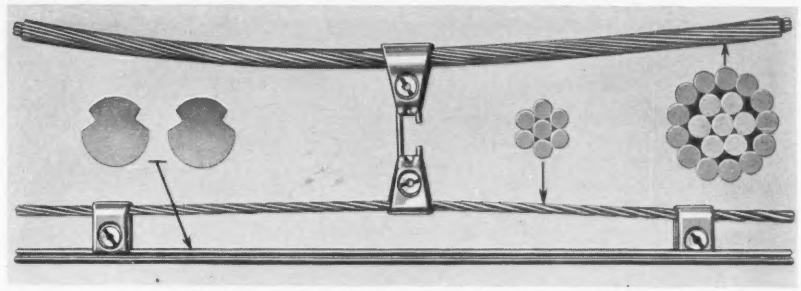


Fig. 5. Catenary System used on D. L. & W. R. R. ✦ ✦ ✦ ✦

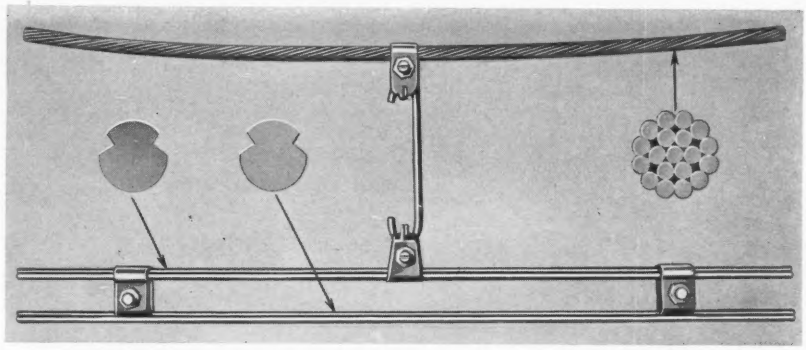


Fig. 6. Catenary system used on Pennsylvania R. R. ✦ ✦ ✦ ✦

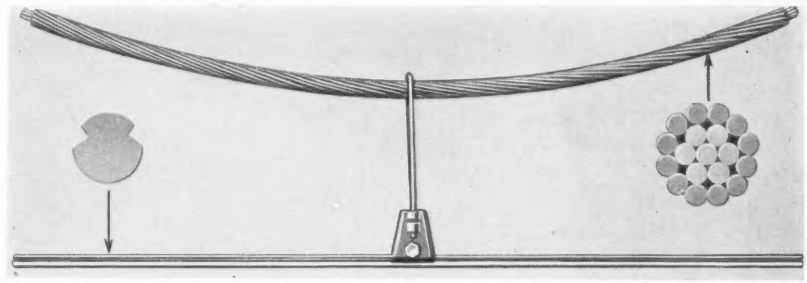


Fig. 7. Catenary system used on Great Northern R. R.. ✦ ✦ ✦ ✦

A SAMPLE of hard-drawn Calsun Bronze wire containing a braze was wound into a closed helix of 0.527 c. to c. diameter and loaded as a helical spring to develop 25,000 lbs. per square inch shear stress in the wire. It was exposed to the weather in an industrial atmosphere and after 9

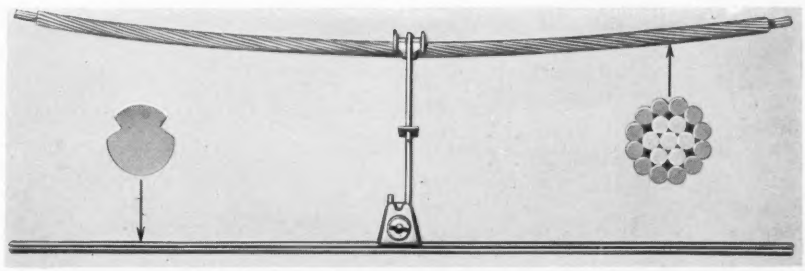


Fig. 8. Catenary system used on Reading R. R. ✦ ✦ ✦ ✦ ✦

*Report of Committee XIII—Application of Corrosion-Resisting Material to Railroad Electrical Construction, 1936, pp. 87-110.

†Proceedings of American Transit Engineering Association.

years is still carrying the strain with no evidence of deterioration or distress.

✦ ✦ ✦

Tension and Corrosion on 7-wire Cable

AS messenger cables are generally used, they are sagged so that the maximum tensile stress occasioned by dead weight, ice or wind and temperature will be not over 50% of the tensile strength of the cable. In other words, the safety factor is 2. A condition as severe as this is encountered only a few times in the life of the span. Under normal atmospheric conditions, the loading probably does not exceed 30% of the strength of the cable.

✦ ✦ ✦

A CALSUN Bronze cable was, therefore, set up and loaded by means of dead weights and a bell-crank lever to **52% of its tensile strength,** illustrated in Fig. 3. Such a loading is more severe than a messenger cable would ever be called upon to endure in railway service. In addition to the unusually heavy load, the cable was placed in the weather in an industrial atmosphere charged with sulphuric acid fumes.

✦ ✦ ✦

THE cable itself was offered no protection of any sort, yet the only effect of the four years' exposure was to produce a thin, velvety-black patina about 0.0003″ thick which can be removed with a few light rubs with a fine emery cloth.

✦ ✦ ✦

Performance of Cable

THE 25-foot gauge length of the heavily loaded cable was watched continuously for changes in length. A light wire of the same composition as the cable strands was strung over the top of the cable and loaded to 15% of its breaking strain. This wire was used as an extensometer, measurements being taken from a cylinder soldered to it and the cable holder. Since it was of the same composition as that of the cable, temperature changes would balance out and only the change in length of the cable, due to stress, be measured. Any slip in the cable connection due to tightening of the holder grip was measured and subtracted from the extensometer reading obtaining thereby exact changes in length of the cable itself.

✦ ✦ ✦

TESTS were made on the cable and individual strands both before and after the four-year sustained load test, with the results shown in table herewith.

✦ ✦ ✦

RESULTS OF TESTS MADE ON CABLE AND ON INDIVIDUAL STRANDS, BOTH BEFORE AND AFTER THE FOUR YEAR SUSTAINED LOAD TEST

Item	Values: As Stranded	Values: After 4 Yrs. in Weather Loaded to 52% of Breaking Strain
Tests on Stranded Cable		
Test No.	87,293	29,890
No. of Wires	7	7
Avg. Diam. of Wires, Inch	.1026	.1027
Pitch of Wires, L. H. Lay, Inch	4.09	4.20
Conductivity, % I. A. C. S. at 20°C.	17.0	.. ..
Proportional Limit, lbs. per sq. in.	72,400	95,000
Johnson's Elastic Limit, lbs. per sq. in.	95,000	108,000
Breaking Strain, lbs.	8363	8210
Tensile Strength, lbs. per sq. in.	144,500	142,000
Fracture	In gauge length	In gauge length
Average of all 7 wires from destranded cable		
Test No.	87,293	29,892
Avg. Dia. Wires, Inch	.1024	.1030
Avg. Breaking Strain, lbs.	1189	1227
Avg. Tensile Strength, lbs. per sq. in.	144,240	147,370
Avg. Elongation in 2″ %	3.4	2.6

The Sustained Load Test—Conclusions

A summary of the results on the foregoing cable subjected to a load of 52% of its tensile strength for four years and exposed to the weather in an atmosphere more than usually corrosive, leads to the following conclusions:

(1) Effect on stretch: Fig. 4 shows the time stretch relationship covering the period December 3, 1925, to January 17, 1930. Note that 89% of the total stretch occurs in the first few hours that the cable is under load and 97% in the first nine months. There is then an extremely slow stretch for the next 1 3/4 years, after which the cable carries its load with absolute constancy of length.

The total stretch in the four years was .75 of 1%, most of which is the elastic stretch proportional to the load.

(2) Effect on elastic limit: The proportional limit was raised 31% and the Johnson's limit 14%. This was probably due in part to release of interfering locked-up stress, in part to an actual strain-hardening of the wire and finally to a tightening of the strands with a more uniform loading of the individual wires.

(3) Effect on tensile strength: The results obtained on the cable and the destranded wires show in general an improvement rather than a deterioration with a very slight loss in ductility.

As a matter of fact the cable carried its unusually heavy load for the last two years of the test without the smallest indication of distress, giving promise of its ability to carry the load indefinitely. It was taken down in order to make room for a new building.

✦ ✦ ✦

Fatigue Limit

WHILE the load in a messenger cable is largely in the nature of a static tensile stress, there is more or less variation due to passing pantographs, temperature changes and swaying in storm winds. There are other uses to which Calsun Bronze wire is put such as for tiller rope, signal cable and other mechanical connections where the fatigue limit is of more importance. Hence, it is desirable to know what this limit is.

✦ ✦ ✦

TESTS made on Calsun Bronze cold drawn to a tensile strength of 75,000 lbs. per sq. in. indicate

(*Please turn to Page 692*)

The Annual Convention of The Wire Association

Bloxdorf Receives Medal Award for 1938 ✦ ✦ ✦ The President's Address ✦ ✦ ✦ Regional Meetings ✦ ✦ ✦ Separate Medal Awards for 1939 ✦ ✦ ✦ The John Mordica Memorial Lecture ✦ ✦ ✦ Publishing of Proceedings ✦ ✦ ✦ The Technical Sessions ✦ ✦ ✦ Some Leading Exhibitors ✦ ✦ ✦ Publication Arrangements ✦ ✦ ✦ ✦

THE Annual Convention of the Wire Association which was held at Detroit, Michigan from October 17 to 21st inclusive, marked a distinct advance over all previous meetings, both in the character of the papers presented and in the resulting discussions. This meeting was also marked by the greatest number of registered members and guests attending these meetings up to this time.

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PRECEDING the opening of the technical sessions of the Convention, there was a luncheon at the Detroit-Leland Hotel attended by the officers and directors, the authors of the papers, and the program committee. Following this luncheon the procedure for the meetings was formulated under the leadership of **L. D. Seymour,** chairman of the Program Committee, with the result that the technical program functioned most efficiently during the entire week.

WALTER R. BLOXDORF
MEDAL AWARD — 1938

Born in Kenosha, Wisconsin in 1905. Employed in the chemical laboratory of the Macwhyte Company from 1923 to 1924. Studied chemical engineering at the University of Wisconsin from 1924 to 1928. Upon completion of these studies, re-entered the employ of the Macwhyte Company in the chemical and metallurgical department. Served as Metallurgist since 1931. Member of The American Society for Metals, The Electrochemical Society, The American Society for Testing Materials, and The Wire Association.

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The Medal Award

THE annual Wire Association medal award presented to the member of the Association "for the most meritorious paper on Wire Manufacture or Fabrication during the year" was awarded to **Walter R. Bloxdorf,** Metallurgist, The MacWhyte Co., Kenosha, Wis., for his paper "Wire Rope."

✦ ✦ ✦

TWO other papers received honorable mention—one for the Ferrous section by **R. R. Tatnall,** Metallurgist, Morgan Works, Wickwire Spencer Steel Co., entitled "Resilience of Springs" and one for the Non-Ferrous section by **J. A. Doyle,** Vice President, W. S. Rockwell Co., New York, N. Y., entitled "Heating Copper Wire Bars."

✦ ✦ ✦

THE awards were made at the annual meeting of the Wire Association by **L. D. Seymour,** Asst. Superintendent, Wire Mill, Canada Works, Steel Co. of Canada, Chairman of the Program Committee. In making the presentation **Mr. Seymour** said:

THE selections were made by vote of the Directors of the Association at a special meeting held for this purpose.

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IN opening the annual meeting of the Association, Mr. F. A. Westphal, the president, said:

Gentlemen:

ONCE again on behalf of the Officers and Board of Directors, it is indeed a pleasure to extend the heartiest welcome to our Eighth Annual Convention of the Wire Association, which is one of the five professional societies that make up the National Metal Congress.

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WE of the Wire Association have been and are progressing in great strides that are reflected in the technical research and good quality of the papers presented at our technical sessions; however, let's not stand still, but continue and drive hard in our pursuits in the future.

✦ ✦ ✦

RODMAN R. TATNALL
HONORABLE MENTION—FERROUS DIVISION

Born in New Rochelle, N. Y., in 1906. Educated at Worcester Polytechnic Institute. First employment one year in Development Dept. of Waltham Watch Co. In 1928, joined Wickwire Spencer Steel Co. in spring production dept. In 1930, was promoted to position of Metallurgical Engineer, and since then has been in charge of experiment and research on spring and spring materials. Member of Wire Association and American Society for Metals.

Advertisement features

Unique architectural forms at the 1939 New York World's Fair Site dramatize modernism and the World of Tomorrow

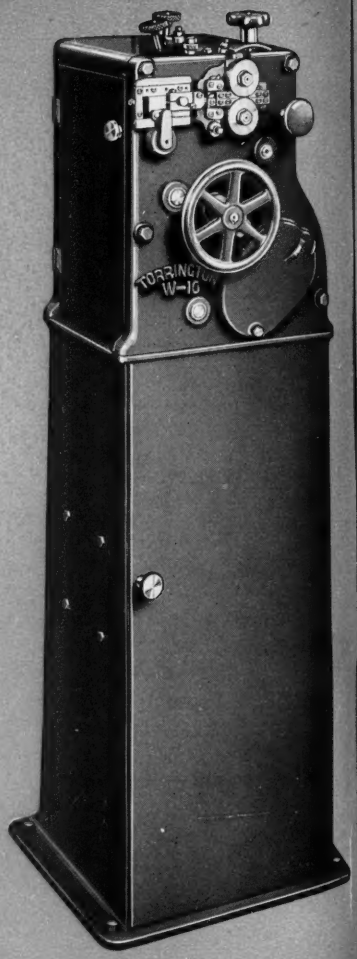
INCREASE PRODUCTION — AND PROFITS

Torrington new high speed, Timken bearing equipped spring coiling machines have established a new era in high speed production of coil springs — are modern — pre-eminent in their field — include patented features and improvements of great significance to spring makers. A new bulletin describes in detail Torrington Spring Making equipment — MACHINES WHICH ARE REVOLUTIONIZING PRESENT-DAY SPRING PRODUCTION. Write TODAY.

Spring Making Machines by

TORRINGTON

THE TORRINGTON MANUFACTURING COMPANY
TORRINGTON, CONNECTICUT • • • U. S. A.

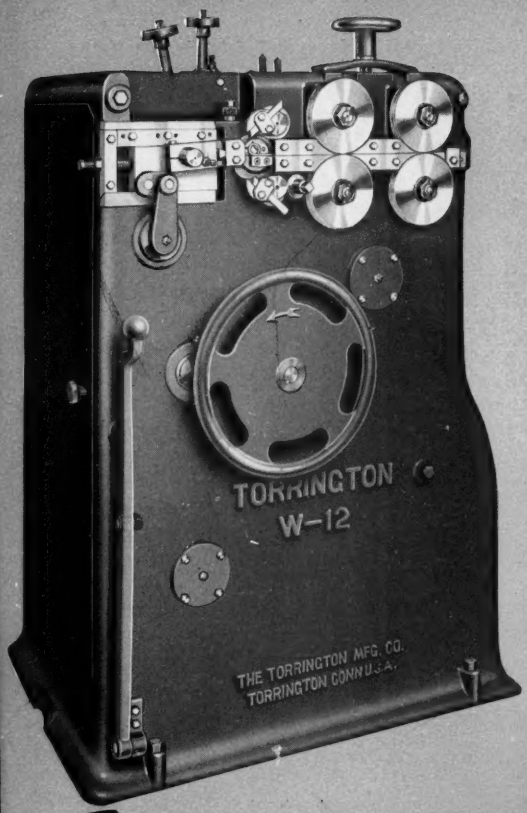


The advertisement at the left featuring TORRINGTON Spring Coiling Machines which first appeared in the July issue of WIRE AND WIRE PRODUCTS has been selected to appear in the national collection of "Best Advertisements of 1938" picked each year by an impartial jury of advertising experts.

1st

The Tor
Torring

# of year'
Machines of year

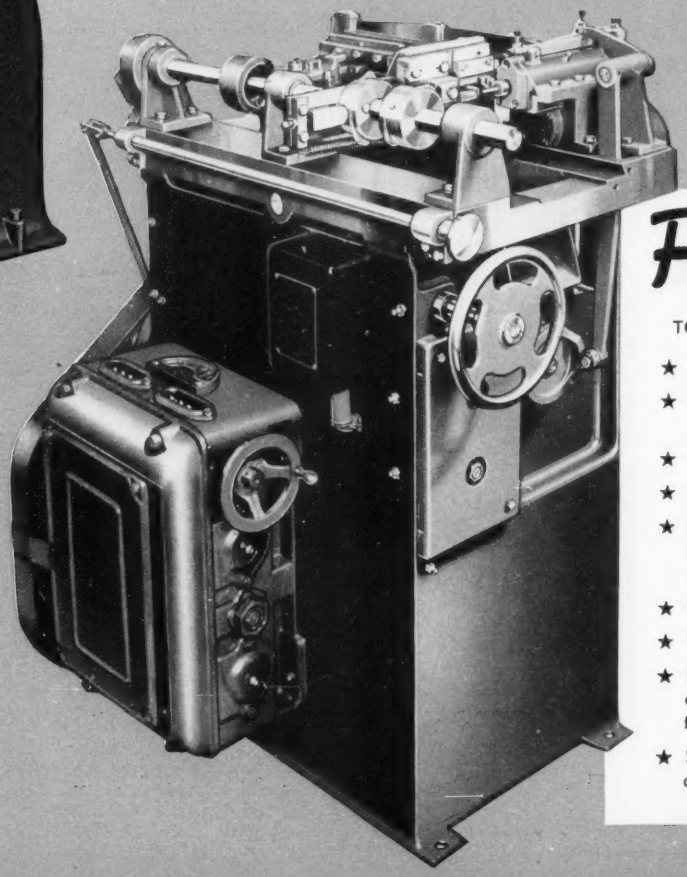


Highly significant among the years's achievements in machine development has been the introduction of TORRINGTON improved spring fabricating equipment — Segment and Clutch type Coilers in nine sizes and Torsion Spring Machines in three sizes. Combining greater accuracy and adaptability with rapid, efficient production and dependable performance, TORRINGTON Spring Making Machines are showing profit-minded spring makers the way to tangible production economies. You will find it well worth-while to investigate these machines . . . and the greater profits which they will enable you to enjoy. Write for illustrated bulletin.

Features

SEGMENT AND CLUTCH TYPE COILERS

- ★ Greater accuracy
- ★ High-speed production
- ★ Rugged, rigid construction
- ★ Timken Roller Bearing equipped
- ★ Convenient, accessible controls for pitch, diameter, cut-off, etc.
- ★ Simple feed adjustment
- ★ Safety hand wheel
- ★ Compact design — fully enclosed
- ★ Ample wire and coil capacity
- ★ Speed variable either by change gears or standard variable speed unit



Features

TORSION SPRING MACHINES

- ★ Ample time for forming
- ★ Provision for mounting tools to form either or both spring ends
- ★ Spindle in horizontal plane
- ★ Accessible forming tools
- ★ Quick adjustment of feed, number of coils, pitch, spindle stop, arbors and cams
- ★ Timken Roller Bearing equipped
- ★ Spindle gears running in oil
- ★ Either slide or roll wire feed for effecting greater accuracy of first end of springs
- ★ Six-splined speed change gears or standard variable speed unit

rrington Mfg. Co
g ton, Conn. - U.S.A

THESE meetings have been a definite reflection of the fine work of the administrations of the past presidents of this Association—namely, the late JOHN MORDICA of the Bethlehem Steel Corporation, and RALPH CLIFFORD of Continental Steel Corporation, and today we are recognized, in our ever-growing membership, both nationally and internationally, as one of America's leading technical associations.

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ACKNOWLEDGMENT is here given of the fine cooperation of JOHN CALLAGHAN of the Steel Company of Canada, Vice President of the Ferrous Section, and E. W. CLARK of General Electric, Vice President of the Non-Ferrous Section.

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IN 1936 we formed the Third Section of this Association — namely, the Cold-working Section that has been making fine progress, and we hope this will become much more enlarged in the immediate future.

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THE program for this year is headed by L. D. SEYMOUR of the Steel Co. of Canada, assisted by Messrs. E. W. CLARK of General Electric, SIDNEY ROLLE of U. S. Metals Refining Company, and WM. H. BASSETT of Anaconda Wire & Cable Company, of the Non-Ferrous Section. Also included, is MAJOR BROWN, our Executive Secretary, in their untiring efforts in the arrangement of our technical sessions.

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MENTION should be made of the Regional Meeting held in Pittsburgh on April 1, 1938. This was a decided success, and much of the credit is due KENNETH BEESON of the Pittsburgh Steel Company for being the spearhead in arranging a visit through his plants and properties, and the fine hospitality extended.

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IT is my recommendation that these Regional meetings be continued as a permanent feature of the Association. Let us hope that the Third Pittsburgh Regional meeting will be as interesting and as productive as the two previous ones. It is understood there is also a movement underway for a Regional meeting in Worcester, Mass., this coming spring.

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THIS year is the first time we have had the feature of having a distinguished guest, such as COLONEL LOUIS JOHNSON, Assistant Secretary of War, to lend prominence to this occasion, and KEN BEARDSLEY of the Carboloy Company, deserves credit for the local arrangements for the luncheon to COLONEL JOHNSON and many details such as press, police escort, contacting military officials of this area.

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FOR the information of those who have joined the Association within the last year or two, please be advised that it is the policy of the Association to rotate the membership of the Board of Directors among its members so that at least two or three new members appear on the Board each year, thus giving the opportunity of injecting new ideas and new life constantly in the plans and development work we are all attempting. This policy has been followed for the past four years and we have had most active cooperation and harmony from all members of the Board of Directors at all times.

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IT is felt that the Medal award should be made on the basis of papers written during the year plus papers presented by members at the Annual Convention, rather than confining the award only to those papers presented at the Annual Convention. The thought behind this idea is that many members who ordinarily do not write for publication but who have real information which would be helpful to the industry as a whole, should be encouraged to present their ideas through the medium of Wire and Wire Products, our official Association publication, and to this end any papers written by members for publication during the period—October 1, 1938 to October 1, 1939, inclusive will be given consideration in making the annual award for 1939.

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IN line with the aforementioned statement of our Cold-Working Section, several members of the Association have suggested it would be a good idea to develop a membership among the fabricators of wire products, and the suggestion was made at the Annual Directors' meeting last March that the publisher of Wire and Wire Products assist the Wire Association in this development. Furthermore, MAJOR BROWN has assured me that if he can secure the cooperation of members of the Association in obtaining such editorial material, we could have an editorial department in the publication along these lines, plus the assistance in developing the membership. It seems to me that the idea of putting the producer of wire and his customer together through the medium of Wire Association papers and Wire Association meetings is an excellent one, and I recommend it to you for your consideration.

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AGAIN, at the Directors' meeting of last March, it was decided to do away with the previous method of reporting proceedings of the technical sessions as in a separate and singular copy. A new plan was adopted whereby the story of the Show will be published in the November Number of Wire and Wire Products, and the proceedings which are considered invaluable by many, especially those who for some good reason cannot attend the Convention, will be published in their entirety in the January, 1939 issue of Wire and Wire Products. It figures out that this will be a considerable saving to the Association—of between $500 and $600 —compared to printing them independently, as previously done. Further in this way we feel the publication of the proceedings will be more widely disseminated information regarding the activities of the Association than heretofore, and at a more economical cost.

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LASTLY, I wish to emphasize to all, the importance of Membership—which is now 332—an increase of 30 over October 1 of last year and a very material increase over the two preceding years. Each of you knows someone who would be interested and should be a member of the Wire Association, therefore, my thought to present to you for your consideration at this time is to have you contact your friends to join the Association to the end that numerically we will become more powerful and as important as we are technically.

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IN conclusion: I wish to extend to you my heartfelt wishes for prosperity, success and health, and trust that we will all be present next year with additional members and friends for the Wire Association.

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Among the Matters Presented at The Annual Meeting and Approved Unanimously Were the Following —

Separate Medal Awards for the Ferrous and Non-Ferrous Groups

AT this meeting it was decided to establish separate awards for the ferrous and non-ferrous divisions — these awards to be made at the 1939 convention and to discontinue the "honorable mentions."

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Publication of Proceedings and Technical Discussions

THE detailed stenographic minutes of the technical discussion and proceedings will be published in full in the January issue of Wire & Wire Products together with a list of registered attendance to facilitate identification of those participating in the discussion.

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THIS new method of handling the proceedings will be followed permanently from now on.

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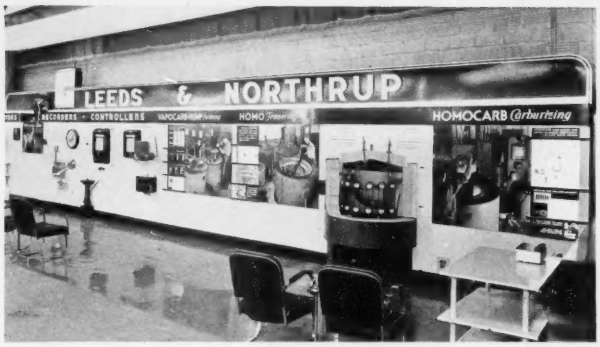
Approval of Minutes of Previous Annual Meeting and of Minutes of Directors' Meeting of March, 1938 and of All Actions Taken at That Time Was Given.

The Principal Points of Interest Presented Were:—

1. That we continue to hold an Annual Pittsburgh Regional Meeting.

2. That we continue the Wire Association Headquarters and "Hospitality Feature" at our annual meetings.

3. That the contract made by the Directors on behalf of the Association with "Wire and Wire Products" and Richard E. Brown, by which the existing publication arrangement be continued and Mr.



✦ ✦ Leeds & Northrup Co., Philadelphia ✦ ✦

Exhibited (in operation): Instruments in operation: Micromax Pneumatic Control is presented to the metal industry. Furnace Section: Homocarb Furnace—Homo Tempering Furnace—Vapocarb-Hump Hardening Furnace. ✦ ✦ ✦ ✦ ✦ ✦

✦ ✦ Norton Co., Worcester, Mass. ✦ ✦

Exhibited: Abrasives, grinding wheels, rubbing bricks and refractories of the types generally used by the steel industry. New types of diamond wheels and the latest advances in the manufacture of Norbide (Norton Boron Carbide) gauges and accessories. ✦ ✦ ✦

Brown retained as Executive Secretary for 10 years at a nominal retainer of $1.00 per year be and is ratified.

4. That an annual lecture by an outstanding member of the Association be given each year and that this lecture be named "The John Mordica Memorial Lecture," in honor of the first President of the Wire Association.

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Vote of Thanks to Mr. Brown

In connection with the luncheon to Colonel Louis Johnson, the Assistant Secretary of War, the following comment was made by Mr. Beeson of the Pittsburgh Steel Company:

" . . . I believe that after this fine luncheon we had today, and the admirable contribution that was made to the Wire Association by the presence of Colonel Johnson, the members of the Wire Association should give a rising vote of thanks to Mr. Brown for arranging the matter, because we all appreciate it very much. I so move."

The motion being unanimously passed, a rising vote of appreciation was given.

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IT was then announced that the 1939 Convention would be held in Chicago, Illinois, from October 16th to 20th, inclusive.

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The Technical Sessions

THE outstanding feature of the technical sessions was a series of three lectures by B. L. McCarthy, Metallurgist, Wickwire Spencer Steel Company, Buffalo, New York, on the following subjects:

1. **"Principles of Metallurgy."**
2. **"Thermal Reactions."**
3. **"Metallurgy of Steel Wire."**

IN presenting these lectures, the author stated that it was his hope to be able to present the metallurgy of steel wire in such simple language that the average wire man could readily grasp the subject. He frankly admitted that this presented some difficulties, but that after the principles outlined in the first lecture were understood, the subject matter of the other two lectures could be very readily absorbed by anyone.

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THESE lectures will be presented in the November, December, and January issues of "WIRE & WIRE PRODUCTS" successively, and the discussions relating thereon will be published in full in the January, 1939, number.

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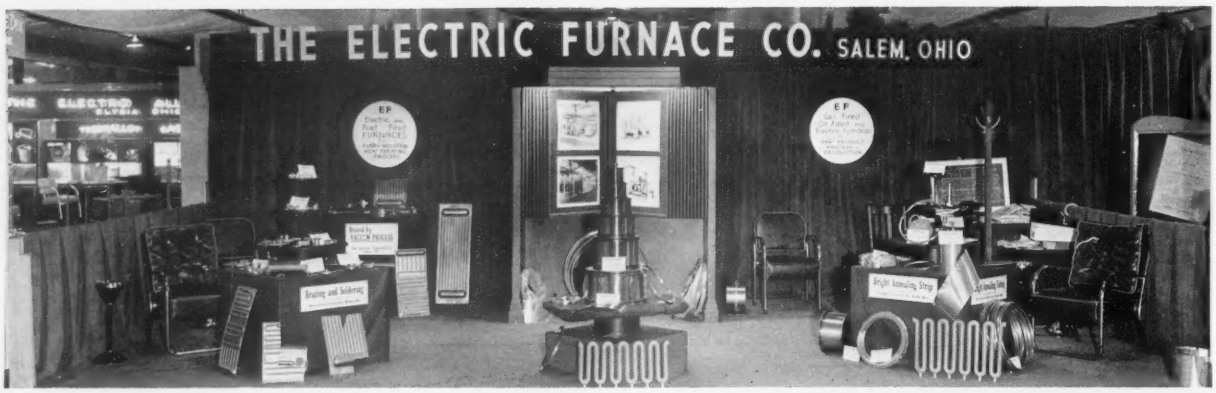
✦ ✦ ✦ ✦ ✦ ✦ Carboloy Co., Inc., Detroit. ✦ ✦ ✦ ✦ ✦ ✦ ✦

Exhibited: Approximately 80 leading tool manufacturers and machine tool builders cooperated with Carboloy Company to display representative samples of all types of tools now tipped with cemented carbide as well as the latest types of machines designed for use with Carboloy. Other features included displays of the Carboloy manufacturing process. Diamond-Impregnated Carboloy wheel dressers, the new bench type Carboloy tool grinder, and an extensive display of wire and tube products produced through Carboloy dies. ✦ ✦ ✦ ✦ ✦ ✦ ✦



The Electric Furnace Co., Salem, O.

Exhibited: Photographs of recent furnace installations and latest developments in special atmosphere equipment for copper brazing, scale-free heat treating and bright annealing ferrous and non-ferrous products including wire, sheet, tubing, strip, stampings, bolts, automotive parts, etc., also samples of material treated in these furnaces. Exhibit also included photographs of outstanding electric, oil and gas fired furnaces built for normalizing, carburizing, short cycle malleableizing, nitriding, forging, annealing and other heat treating processes.

The Aetna-Standard Engineering Co., Youngstown.

Exhibited (in operation): The 12-inch Aetna-Connor Continuous 5-draft wire drawing machine. The 22-inch Aetna Continuous 3-Draft wire drawing machine.

Sleeper & Hartley, Inc., Worcester, Mass.

Exhibited (in operation): 1—S & H No. 1 Universal Coiler, 48" Model, Series 666; 1—S & H No. 1 Improved Torsion Spring Machine, Series 614.

THE complete discussions on all meetings will include many interesting points that were brought out. The effect of age hardening on the manufacture of spring wire was discussed. Why wire for washers when cold drawn pulls apart while that run through a turks head goes together was a subject which created quite some interest. The necessity for uniformity and freedom from broken wires, etc., in wire cloth for industrial uses was discussed at length. The effect on tensile and yield of annealing treatments applied after cold drawing brought out many points of interest. The development of a superior coating for drawing cold heading wire was announced, and a prolonged discussion on the subject of the disposal of waste acid to meet existing and pending state laws resulted in many interesting suggestions. The announcement of a method of producing an aluminum-steel wire and its commercial applications created a great deal of interest, as did the paper by Mr. Doyle on "Heating Copper Wire Bars." This particular paper was on a most controversial subject, outlining as it did a suggestive method for the improvement of copper wire rods through the improvement of the basic copper. Details of the new chromium copper alloy wire and its commercial applications were discussed together with many other subjects.

Firth-Sterling Steel Co., McKeesport, Penna.

Exhibited (in operation): The display included all types of Firth-Sterling Stainless steels, Globe Drill rods and wire. Firth-Sterling tool steels, die steels. Many types of Firthite Cutting Tools, and many non-Standard Firthite tools of very recent design. Several types of Firthaloy wire drawing dies, tube drawing dies, etc., as well as all types of wear resisting parts.

Assistant Secretary of War Addresses The Wire Association

By Richard E. Brown,
Editor, "Wire & Wire Products"

THE outstanding highlight of the Convention was the address delivered by Colonel Louis Johnson, the Assistant Secretary of War, at the luncheon held at the Detroit-Leland Hotel on Wednesday. The subject of his talk was "Industrial Mobilization" but it was made specific in its application to the wire industry.

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THE address is printed on the pages following but it is essential to note that in addition to the address as published, Colonel Johnson interpolated quite some material "off the record." The result was that he literally brought his audience to their feet at the end of his speech. All of us who were present at this luncheon pay tribute to the dynamic, forceful personality of Colonel Johnson and to the response which he evoked from his audience, not only from the standpoint of the business interest created by his address, but from the viewpoint of the spirit of true Americanism which he presented to us. America needs more men like Colonel Johnson to deliver messages of this kind.

THE introduction of Colonel Johnson to the members of The Wire Association and guests by Mr. F. A. Westphal, follows:

Members Of The Wire Association,
Guests From The National Metal Congress,
Members Of The Detroit Chapter Of The U. S. Naval Academy Alumni Ass'n:

TODAY is a momentous occasion for the Wire Association! Our distinguished guest went through the rigors of war and smelt plenty of powder and gas in 1918, particularly in the fighting of the Meuse-Argonne drive as a Captain of Doughboys.

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AFTER the war he maintained his individual obligation to his community, state and nation, and demonstrated this fact by serving the American Legion from the lowest to the highest rank, and in 1932 he held the potent position of National Commander of the American Legion. Twenty years ago many of us here toiled on the industrial front line and backed up our armed defenders. Many of us are American Legionnaires who fought and shed our blood directly for our Country over there, therefore, we all the more appreciate this important phase of our program.

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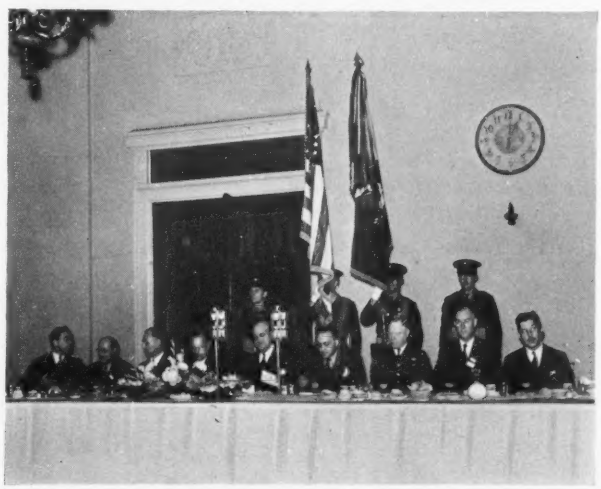
COLONEL JOHNSON, since joining the War Department, has attempted to perform the stupendous task of organizing the industrial front line, and has been driving hard to make America conscious for industrial preparedness for war. He is an indefatigable worker and is traveling this country widely to deliver this message of industrial preparedness. Gradually the Nation is organizing and instituting his ideas of the vital necessity of correct coordination in supplying all munitions in time of conflict. In this very day of impending crisis and potential national emergency we should closely adhere to his message, recognize his plea for cooperation for that "M" day, which will mean to all of us Mobilization Day for industry, as well as our armed forces. Ladies and Gentlemen, it is my pleasure to present to you the Honorable Louis Johnson, Assistant Secretary of War.

Reception Committee to Colonel Johnson. Front Row—John Callaghan, F. A. Westphal, Colonel Johnson, E. W. Clark, R. E. Brown. ✦
Rear Row—Sidney Rolle, W. H. Bassett, Jr., K. R. Beardslee. ✦



Speakers' Table—Color Guard, 2nd Infantry, U. S. Army. ✦

INDUSTRIAL MOBILIZATION

An address by The Honorable Louis Johnson, The Assistant Secretary of War at the Annual Meeting of The Wire Association at Detroit, Michigan, October 19, 1938. ✦ ✦ ✦ ✦

Members of The Wire Association:

YOU are heir to one of the oldest of human crafts. Your skill traces itself back to the cunning workers in metal, whose apt skill and deft hands "did beat the gold into thin plates, and cut it into wires, to work it in the blue, and in the purple, and in the scarlet, and in the fine linen." Time has increased the usefulness of your trade. Neither the advent of the machine nor the introduction of production in the mass has reduced the demand for your invaluable services nor diminished the sterling worth of your skillful craftsmanship.

✦ ✦ ✦

TO the Army, you furnish its very life's blood. Without your products, the senses of our military forces would become numb. Our Army would become paralyzed. Our commander in the field could raise no voice of authority to his far-flung troops. Our directors of artillery fire would lose the value of the eyes of their observers upon whose reports they depend for accurate adjustments. Our leaders of infantry would be without ears to hear the order for advance or retreat. Without the telephone, coordinated and successful effort on the modern battlefield would be impossible.

✦ ✦ ✦

IN battle, Army telephone lines must submit to terrific punishment. Machine gun bullets spray them. Artillery shells cut them. Aerial bombs crush them. No wire made by the ingenuity of mere man can withstand such onslaught —but telephone communications must go on. A break or a gap in material, human hands often must repair, splice and join.

✦ ✦ ✦

TOWARD the maintenance of telephone communications, so vital toward success in battle, American soldiers have made tremendous sacrifices. Pick up any list of Army citations for bravery in action and you will find one example after another of heroism in the face of fire and death to protect these life lines of communications between the various elements that make up the military machine. Let me cite you just a few.

✦ ✦ ✦

Colonel Louis Johnson, Assistant Secretary of War and Mr. F. A. Westphal, President of The Wire Association. ✦ ✦

THERE is the case of **Lieutenant Charles Kilbourne,** now a major general, retired, who "within a range of two hundred and fifty yards of the enemy, and in the face of a rapid fire, climbed a telegraph pole at the east end of the bridge and in full view of the enemy cooly and carefully repaired a broken telephone wire, thereby reestablishing telegraphic communications to the front." That act of chivalry is dated in 1899 and took place in the Philippine Islands.

✦ ✦ ✦

WITH some variations, we have practically identical incidents repeated on the Western Front. As a tribute to the State of Michigan, our hosts of today, let me mention one or two of the heroic deeds of her sons in the field of telephone communications.

✦ ✦ ✦

THERE is **Sergeant John R. Lamb,** of Rockford, of Michigan's own 32nd Division, who went out without orders and upon his own initiative, when heavy shelling and machine gun fire destroyed telephone communications, and repeatedly patrolled the line making repairs and reestablishing communications. "He worked indefatigably day and night during a period of seven days and refused to rest or seek a place of safety while he could find work to do. He was finally forced to go to a hospital by reason of complete exhaustion."

THERE is also **Sergeant Harry Mansfield,** of Bay City, another hero of the "Iron Jaw" Division, who "while continually under heavy shell fire laid and maintained lines of communication within his area with utter disregard for his personal safety."

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TO come even closer to home, there is the citation of one of your own members of the Wire Association, an officer in the Regular Army and a member of my own staff in Washington, **Captain Frank W. Bullock,** who, during the Meuse Argonne offensive, succeeded in getting a telephone line into a small town and maintained it under heavy gas and shell fire.

✦ ✦ ✦

YOU and I and every patriotic American are proud of our intrepid and gallant soldiers and their brave achievements, but all of us would be satisfied with fewer heroes and sturdier telephone wires.

✦ ✦ ✦

IN battle, the expenditure of telephone wire is stupendous. From June to November, 1918, our front line troops consumed 108,921 miles of this one product and at the time of the Armistice, demands for more and more wire were pouring into GHQ from every division front.

✦ ✦ ✦

PRODUCTION in your industry, unfortunately, could not keep pace with our tremendous needs. In October, 1918, you were producing eight thousand miles of telephone wire per month. The Signal Corps was demanding of the War Industries Board that you multiply your capacity more than eight hundred percent. It set sixty-five thousand miles per month as the minimum requirement.

✦ ✦ ✦

PERHAPS the Army was asking the impossible but the demands of Mars always are just beyond the apparent limits of human capacity; and to achieve victory, they somehow must be met.

✦ ✦ ✦

TODAY, I am very happy to report to you that the situation in the wire industry has improved tremendously. Today, you are better prepared than ever before to meet the demands of the Army, not only for telephone lines, but for all of the eight hundred different wire products that we need for war. With the hearty cooperation of your association, the Army has made a survey of your trade and has found it physically equipped and well organized to meet our demands in an emergency. I congratulate you on the executive ability of your leaders. You have much cause for pride in the scientific skill of your foremen and your workers.

✦ ✦ ✦

YOU have the machinery to meet the demands of any war within the concept of modern military needs. Unfortunately, however, you still have a very serious bottleneck that must be removed before you can fully meet the needs that may be made upon you. Today, you have a adequate supply of skilled operators with a record of excellent performance. Will you be able to maintain the superb craftsmanship which now characterizes your trade when the demand for your products is multiplied six, seven or perhaps eightfold? Will you be able to recruit an additional supply of skilled operators to maintain and run your delicate machines? Your answers, I am sorry to say, will have to be in the negative.

✦ ✦ ✦

YOU are not alone, however, in facing the prospects of a shortage in skilled workmen. Not only your trade, but all American industry which may be called upon to produce munitions of war, is confronted with a similar problem. To assure us an adequate supply of skilled workmen is a challenge to all patriotic Americans interested in adequate national defense. We are grappling with the situation in the War Department but, frankly, we have not yet met it successfully. It may help us, perhaps, if we analyze the problem in greater detail.

✦ ✦ ✦

IN the first place, we all realize that at this very moment there is an impending shortage of skilled labor in many of our key national defense industries. In the second place, we must recognize the fact that in an emergency the shortage will be felt more keenly. From the Army will come a great demand for skilled soldiers to operate its anti-aircraft guns, maintain its planes, repair its armament and overhaul its engines. From industry will come a call for more and more craftsmen in the factories to keep pace with the growing demands for weapons, armament and munitions of all sorts which the Army has ordered.

✦ ✦ ✦

HOW to meet these conflicting demands is the problem I lay before you today. With your co-operation and with the aid of industry, the War Department is confident that a solution satisfactory to the mobilization of America for national defense in an emergency will be attained.

✦ ✦ ✦

THE bottleneck that I pointed out to you in

Mr. Westphal, Colonel Johnson, Major Brown, Mr. Beardslee. ✦

the wire industry is but one of many confronting not only your trade but all of America in our industrial mobilization program. These, we must remove. We are making progress, but there is still much work ahead of us.

✦ ✦ ✦

THE situation of 1917-1918, we have determined never again shall be repeated. War was declared on April 6, 1917. Not until the glorious battle of Cantigny was won, on May 28, 1918, did an American division on the Western Front carry its full burden on the firing line.

✦ ✦ ✦

YOUR own President, **Captain Frederick A. Westphal,** was present at that engagement and was severely wounded while gallantly directing the fire of his artillery guns. He will vouch for the fact that it had taken us fourteen months to get the soldiers of his division to the front and to provide them with shoes and clothing. He will corroborate the fact that his comrades in arms were carried across the seas on transports, most of which belonged to **other** countries. He remembers, as all of us must never forget, that to put our men on the firing line and to equip them with artillery and ammunition, we depended principally on our allies. The artillery pieces that the soldiers of Captain Westphal's organization, the famous Battery C of the 6th Field Artillery of the First Division, fired at Cantigny were the French 75's that came to us from French arsenals.

✦ ✦ ✦

MANY of the principal causes for the delays in our military effort are directly traceable to industrial failures. Let me mention but one item, one of your own wire products, which was responsible for some of the loss of valuable time. The absence in America of a machine to manufacture wire eyelets for the doughboy's breeches, through which he could pull his laces, caused a delay of many months in the production of clothing for the fighting man. In 1917, these machines were made only in Europe. Your industry ultimately met the issue but that delay in procurement was one of the contributory causes toward the lag in our production of military clothing.

✦ ✦ ✦

WHILE we slowly were gaining momentum, our seacoasts, our navy yards, our ammunition plants and our training stations were enjoying complete immunity but only because the fleets and armies of other nations, aided by our own Navy, were there to protect us.

✦ ✦ ✦

IF an emergency should arise again, we can hardly expect that our shores will be similarly protected for fourteen months by friendly powers while we have an opportunity to marshal for war purposes our tremendous industrial assets. Our whole program of industrial mobilization must aim to cut down to a minimum the time necessary for American industry to change from peace to war production.

✦ ✦ ✦

TO achieve success, we need the help and encouragement of every element of our American life, of capital and of labor, of private industry and of the government, and I hasten to assure you that all of us are working harmoniously together toward the common goal of national defense.

✦ ✦ ✦

IN the world of today, national defense has become a matter of everyday vital concern to every patriotic American. The reversion to the barbaric code of "might makes right" has swept across Europe and Asia as a menace to all civilization and we in America may wake up some day to learn that we, too, have not proved ourselves immune against this deadly formula. We must be prepared, but mark you, not for offense, but for defense, not for aggression, but for protection, not to wage war, but to keep out of war.

✦ ✦ ✦

WE are the fortunate heirs of a great human achievement. It is our solemn duty to keep inviolate the ideals of liberty and equality for which man has struggled for thousands of years and has begun to realize only in the short span of the existence of the American Republic, and to pass them down to our children for their security and for their happiness.

✦ ✦ ✦

AMERICA is indeed the most fortunate of countries and we, its citizens, are the happiest people on earth, but we, too, must realize that we have not yet reached the millenium. There is still much to be done. Our standards of living must be made higher. Our opportunities for education and for self-development must be made even broader. Our business must be made sounder. Our lives must be made happier. Our national defense must be made strong. It is toward this lofty goal that I pledge you the support of our Army. It is toward these desirable ends that all of us patriotic Americans should eternally strive.

Colonel Johnson with Col. Churchill and Major Black of the 2nd Infantry, United States Army, and Mr. Westphal—"All Off the Record". ✦

Exports and Imports of Wire

Exports of Iron and Steel Wire Products in Aug., 1938 and Aug., 1937
(In gross tons)

	AUGUST 1938	JULY 1938	AUGUST 1937
Wire rods	357	1,312	7,858
Strip steel	4,871	2,712	7,703
Plain, black or galvanized iron or steel wire	2,383	5,667	6,098
Barbed wire and woven wire fencing	3,259	4,054	4,092
Woven wire screen cloth	106	93	101
Wire rope	284	204	1,119
Insulated iron or steel wire and cable—see analysis below			
Other wire and manufactures	363	539	748
Wire nails	1,654	2,264	398
Tacks	13	20	37
Other nails, including staples	325	555	279
Bolts, machine screws, nuts, rivets and washers	565	643	731
Total, these 11 classifications	14,180	18,063	29,164

Imports of Iron and Steel Wire Into the United States
(In gross tons)

Concrete Reinforcement bars	248	89	58
Hollow bar and drill steel	56	47	238
Wire rods	220	278	1,475
Barbed wire	1,068	692	1,781
Round iron and steel wire	118	107	493
Telephone and telegraph wire	1	.....	4
Flat wire and strip steel	154	168	307
Wire rope and strand	156	99	237
Other wire	96	97	79
Hoops and bands	908	1,040	1,784
Nails, tacks and staples	831	626	1,368
Bolts, nuts and rivets	1	12	109
Total, these 12 classifications	3,857	3,255	7,933

Exports of Insulated Wire and Cable, August, 1938

	Foreign		To U. S. Possessions	
	Pounds	Dollars	Pounds	Dollars
Rubber covered wire	736,158	$146,185	177,668	$29,578
Weatherproof wire	244,822	37,322	30,148	4,692
Other insulated copper wire	369,841	83,661	79,425	11,792
Nickel-chrome electric resistance wire	34,897	38,249	.....	.....
Total, these 4 classifications	1,385,718	$305,417	257,241	$46,062

Exports

EXPORTS of iron and steel products (scrap excluded) from the United States in August topped the 100,000-ton mark for the 23rd consecutive month. Shipments aggregated 134,110 tons valued at $8,810,925 in comparison with 137,276 tons valued at $9,832,797 in the preceding month and 408,081 tons valued at $24,119,200 in August 1937, when exports were at close to record level.

✦ ✦ ✦

PIG iron exports in August were outstanding on a tonnage basis at 19,756 tons in comparison with 10,371 tons in the preceding month and 114,035 tons in August 1937. Of this total, Japan took 18,949 tons. Ranking next, plate (boiler, 'other', and fabricated) shipments totaled 13,150 tons against 17,390 tons and 55,034 tons with the Netherlands taking 4,685 tons and Canada 1,122 tons—the outstanding markets in a widespread trade.

✦ ✦ ✦

RAIL exports in a trade aggregating 12,665 tons registered a sharp increase from the 1,960 tons shipped in July and compared with 7,890 tons in August 1937. August shipments (mostly relaying rails) went chiefly to Hong Kong, 8,317 tons; China, 2,318 tons; and the United Kingdom, 1,200 tons. Exports of black steel sheets, the next-ranking product, amounted to 11,949 tons against 14,730 tons and 28,075 tons and, in a widespread trade, went to mostly the Soviet Union, 3,777 tons; and Canada, 3,447 tons.

✦ ✦ ✦

STEEL bar exports at 11,838 tons compared with 9,397 tons and 14,656 tons and also reached numerous markets, those outstanding being the Philippine Islands, 4,590 tons; Japan, 1,722 tons; Brazil, 781 tons; and Cuba, 605 tons. Following came tin plate exports (likewise world-wide in distribution) with 9,163 tons against 12,802 tons and 29,170 tons. The outstanding outlets were Canada, 2,528 tons; the Union of South Africa, 855 tons; the Philippine Islands, 771 tons; and Mexico, 664 tons.

✦ ✦ ✦

RAIL exports in August registered a sharp increase of 10,705 tons in comparison with the July total, other increases of moment occurring in those of pig iron, 9,385 tons; cast-iron pressure pipe, 6,058 tons; unlined tanks, 2,835 tons; and steel bars, 2,441 tons. The steel ingot total plummeted 17,240 tons from the July trade, other declines being particularly noted in plate, 4,240 tons; tin plate 3,639 tons; and black steel sheets, 2,791 tons.

✦ ✦ ✦

AUGUST scrap exports at 108,029 tons valued at $1,478,545 compared with 126,423 tons valued at $1,667,487 in July and 478,296 tons valued at $9,305,239 in August 1937 and were taken mostly by Japan, 44,221 tons; Germany, 28,355 tons; and Italy, 20,072 tons. Shipments in the first 8 months of the current year totaled 2,032,765 tons valued at $31,762,076 against 3,075,699 tons valued at $61,149,443 in the corresponding period of last year.

✦ ✦ ✦

SHIPMENTS to Japan in August totaled 20,202 tons and the principal items in this trade were pig iron (18,949 tons), and steel bars (1,722 tons). Following came exports to Canada (18,626 tons), the chief products being black steel sheets (3,447 tons), strip steel (2,717 tons), skelp (2,614 tons), tin plate (2,528 tons), and shapes (1,759 tons). The third market of importance was the Philippine Islands which took 16,710 tons of mostly cast-iron pressure pipe (5,380 tons), steel bars (4,590 tons), and galvanized steel sheets (1,931 tons). Next-ranking,

(*Please turn to Page 682*)

Exports and Imports of Wire

(*Continued from Page 681*)

Hong Kong took 10,662 tons of chiefly rails (8,517 tons). Then came the Soviet Union with 9,408 tons of principally black steel sheets (3,777 tons), unlined tanks (3,443 tons), and strip steel (1,181 tons). Brazil followed with 5,722 tons of mainly barbed wire (1,006 tons), heavy rails (814 tons), galvanized steel sheets (324 tons), and black steel sheets (319 tons).

✦ ✦ ✦

Imports

THE United States in August imported 18,404 gross tons of iron and steel products (excluding scrap) valued at $1,182,741 in comparison with 14,094 tons valued at $955,215 in July and 38,379 tons valued at $2,543,241 in August 1937.

✦ ✦ ✦

FROM the standpoint of tonnage, hoops and bands represented the leading product imported. The 3,534 tons received compared with 4,125 tons in July and 1,784 tons in August 1937, and came from Belgium, 1,958 tons; France, 1,138 tons; and Germany, 438 tons. Next-ranking, steel pipe receipts totaled 2,688 tons against 1,242 tons and 10,971 tons and were taken from principally Germany, 1,424 tons; Belgium, 337 tons; France, 291 tons; and Sweden, 242 tons. Ferromanganese and spiegeleisen followed with 2,630 tons against 1,512 tons and 2,252 tons and came from chiefly Canada, 955 tons; and Norway, 950 tons. Structural shapes came next with 2,335 tons against 2,507 tons and 4,170 tons and were received from mostly Belgium, 1,703 tons; and France, 391 tons. Fifth-ranking were steel bars whose total of 1,794 tons compared with 973 tons and 2,952 tons and came from chiefly Belgium, 981 tons; and Germany 328 tons.

✦ ✦ ✦

BELGIUM was the principal source of the August import trade, and accounted for 6,041 tons in comparison with 4,620 tons in July and 6,696 tons in August last year. The principal items in this trade were hoops and bands, 1,958 tons; shapes, 1,703 tons; steel bars, 981 tons; and steel pipe, 337 tons. Germany followed with 4,540 tons against 5,161 tons and 14,368 tons and here the outstanding products were steel pipe, 1,424 tons; barbed wire, 953 tons; nails, tacks. and staples, 655 tons; hoops and bands, 438 tons; and steel bars, 328 tons. France ranked next with 2,478 tons against 664 tons and 3,049 tons of chiefly hoops and bands, 1,138 tons; shapes, 391 tons; steel pipe, 291 tons; and steel bars, 287 tons. Canada was fourth in importance with 1,339 tons against 522 tons and 1,498 tons. The outstanding item in this trade was spiegeleisen (955 tons).

✦ ✦ ✦

FOURDRINIER AND OTHER PAPER-MAKING WIRE imports at 20,027 square feet as against 29,343 square feet and

(*Please turn to Page 696*)

MICROMETER PRECISION — MICRO-WELD — ELECTRIC WELDING

MODEL "E"
MICRO-WELD BUTT WELDER

Model E weighs only 50 pounds and is so simply designed that anyone can weld wires from No. 4 to No. 20 gauge with it—instantly changing from one gauge to another.

A complete portable unit machine for general purpose Butt Welding, instantly adjustable for various sizes of wire and perfectly adaptable for all wire manufacturing and fabricating requirements.

✦ ✦ ✦

THIS Welder is provided with a specially designed, sensitive limit switch, operating automatically with consistently uniform results on even the smallest sizes of wire, where reduced upset spring pressure is necessary. Tungsten contact tips are used in this switch to eliminate the maintenance and adjustment ordinarily required on copper contacts, which are customarily used for this service. By using the best material available in this equipment, positive, accurate results are secured under all conditions.

✦ ✦ ✦

EVERY working part of the machine is enclosed and protected from dirt and corrosion from acid fumes. The only servicing that is necessary, is an occasional brushing of the dies with the wire brush which comes with the machine, and an occasional oiling with Three-In-One oil in the four oil holes which are visible on the index barrel and slides.

✦ ✦ ✦

HIGH electrical efficiency, with only 2½ KW rating at full capacity, allows light socket operation, which further increases the general utility of this adaptable Welder.

✦ ✦ ✦

FOR especially rugged service or for traveling crane mounting, this machine is also available made from high strength bronze, at no additional increase in price.

✦ ✦ ✦

Your inquiries are solicited.

MICRO PRODUCTS COMPANY — MICRO-WELD — 20 N. WACKER DRIVE • CHICAGO

A Review of Recent Wire Patents

No. 2,129,063, WIRE TYING MACHINE, Patented Sept. 6, 1938 by Oscar Kind, Rodenkirchen, near Cologne, Germany.

Fastening the wire bindings of packages is accomplished by two twisting pinions spaced from each other so that the sections of wire to be united are twisted together at four successive points with a screw pitch inclination, the directions of twisting at each two points being opposed, resistance to operation being divided by rotation of one pinion while the other pinion is fixed.

✦ ✦ ✦

No. 2,129,251, BEDSPRING, Patented Sept. 6, 1938 by George F. Venzke, Minneapolis, Minn.

Means is provided to prevent bedsprings from sagging in the middle, by counteracting the tendency of the substantially centrally located coils to yield downwardly. As an example, arcuate leaf springs are provided which are supported at their ends by cross wires of the spring frame, and at their intermediate portions arch upwardly and extend through the intermediate convolutions of the centrally located coils.

✦ ✦ ✦

No. 2,130,318, WIRE FORMING MACHINE AND METHOD, Patented Sept. 13, 1938 by Charles C. Cruzan, Poughkeepsie, N. Y., assignor to Trussell Manufacturing Company, Poughkeepsie, N. Y., a corporation of New York.

A flat zigzag wire strip is fed to a pair of companion dies having cooperating stepped bending surfaces by feed devices toothed to engage the strands of the zigzag wire strip, for forming the strip into a ring shape such as employed in helical ring binders for books having marginally perforated leaves.

✦ ✦ ✦

No. 2,130,394, METHOD AND APPARATUS FOR MANUFACTURING ELECTRICAL CABLES, Patented Sept. 20, 1938 by Maurus Klein, Lausanne, Switzerland.

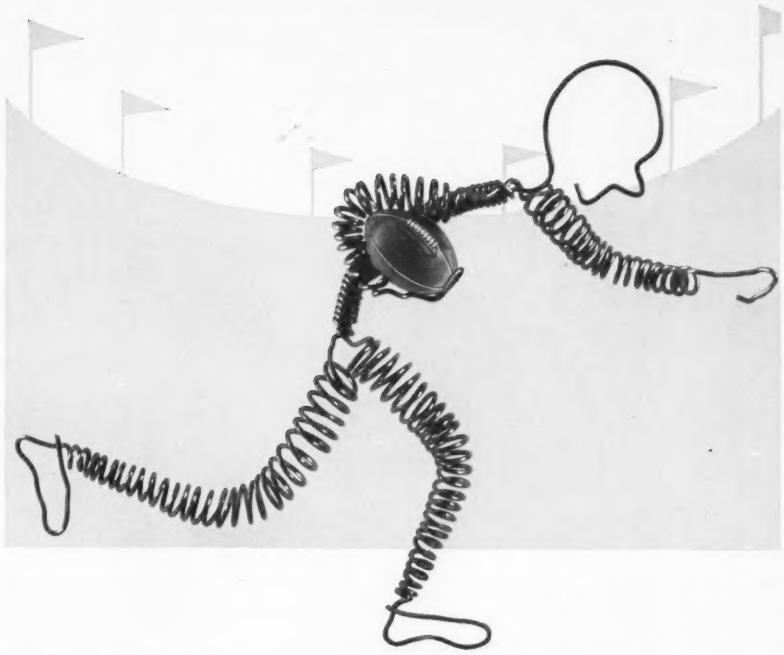
In the manufacture of electrical cables for telephone transmission, comprising pairs of twisted conductors, two such pairs being again twisted to form a set, the conductors are twisted while applying frictional or deformation brakes on each of the conductors. By the present invention, this method of directly braking the conductors is improved, and a cable twisting machine suitable for performing this method is provided, and comprising brakes acting directly on the strands or set of strands.

✦ ✦ ✦

No. 2,130,396, METHOD AND MEANS FOR FORMING COIL BINDINGS, Patented Sept. 20, 1938 by Daniel Madden, Portland, Oregon.

A spiral binding for pages provided with a series of perforations along one margin is produced by forcing a relatively soft wire endwise into a fixed die defining a spirally extending pathway, without the necessity of providing moving parts except for the feeding means.

(Please turn to Page 684)



Wire **carries the Ball**

If production is to roll along with well-oiled precision and crash over the quota goal, your wire has to play a smooth and dependable game.

The metallurgical coaching staff at Keystone is noted for turning out wire that meets the requirements of the most exacting manufacturers. You call the play, and we'll give you a wire that can carry the ball!

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STEEL & WIRE CO., Dept. W, PEORIA, ILL.

HIGH CARBON or LOW CARBON

SAMSON SPRING WIRE — REG. U.S. PAT. OFF. — KEYSTONE STEEL & WIRE CO. PEORIA, ILL.

Bright . . . Tinned
Coppered
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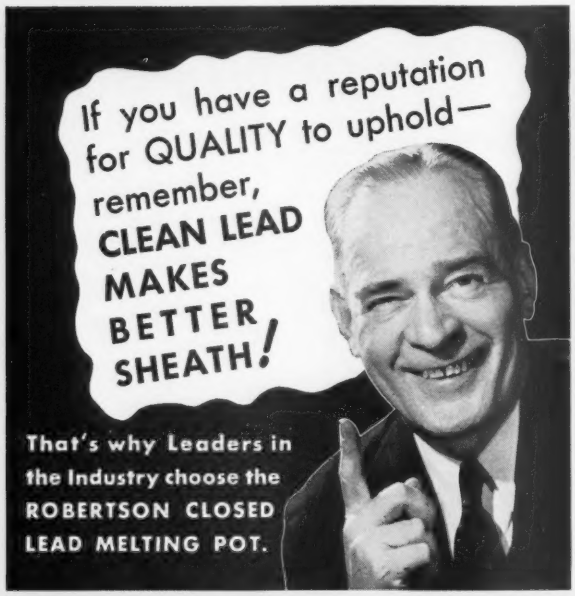
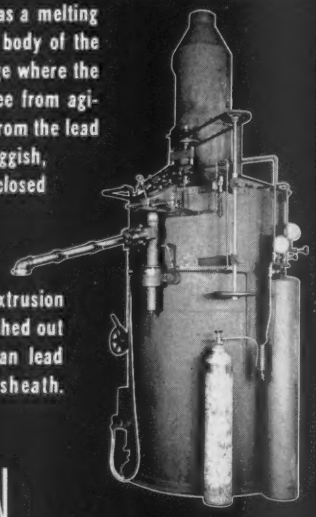

If you have a reputation for QUALITY to uphold—
remember,
CLEAN LEAD MAKES BETTER SHEATH!
That's why Leaders in the Industry choose the ROBERTSON CLOSED LEAD MELTING POT.

In the Robertson Closed Lead Melting Pot, CO_2 gas is used to keep down the formation of oxides over the lead in the melting pot and also during the process of filling the extrusion cylinder with lead.

The large valve opening with free flow helps to quickly fill the extrusion cylinder; the valve is entirely outside of the melting pot so that it may be easily cleaned and serviced.

The filling tube serves as a melting chamber and the main body of the pot serves as the storage where the molten lead is quite free from agitation. Oxides and dirt from the lead pigs, which may be sluggish, float to the top of the closed quiet storage space and are trapped. Only clean lead is drawn from storage to extrusion cylinder, previously flushed out with CO_2 gas . . Clean lead makes better cable sheath.



ROBERTSON
LEAD MELTING POT CLOSED TYPE

JOHN ROBERTSON COMPANY, INC.
125-137 Water Street, Brooklyn, N. Y.

A Review of Recent Wire Patents

(Continued from Page 683)

No. 2,130,477, WIRE STRETCHER AND SPLICER, Patented September 20, 1938 by William J. Alexander, Cora, Wyo.

The device is operated by both hands, one hand holding the body of the stretcher, by means of a handle, and the other hand operating a crank to tighten the wire so there is no danger of the wire stripping off the stretcher and injuring either hand, particularly in the case of barbed wire.

✦ ✦ ✦

No. 2,131,071, BEDSPRING CONSTRUCTION, Patented Sept. 27, 1938 by Solomon Raduns, Brooklyn, N. Y.

The upper frame is provided with two resiliently suspended and supported platforms of strips, wires or springs, which are supported from the lower portion of the spring construction by vertical coil springs and which are suspended from the periphery of the bed and connected to each other by longitudinally or laterally extending coils. The platforms are therefore so arranged that they may be more or less independently depressed, and whereby a depression in one platform does not result in substantial depression of the other platform.

✦ ✦ ✦

No. 2,131,520, ALUMINUM ALLOY, Patented Sept. 27, 1938 by Joseph A. Nock, Jr., Tarentum, Pa., assignor to Aluminum Company of America, Pittsburgh, Pa., a corporation of Pa.

Zinc and cadmium are utilized in aluminum base alloys to inhibit stress corrosion. One example of such an alloy contains from 2 to 12 percent copper, 0.1 to 2 percent silicon, 0.005 to 0.1 percent tin, 0.005 to 0.03 percent magnesium, 0.01 to 0.15 percent cadmium and 0.1 to 3 percent zinc, the balance being aluminum. The alloys are heat treated and artificially aged.

✦ ✦ ✦

No. 2,131,713, ANTISKID CROSS CHAIN, Patented Sept. 27, 1938 by Frank E. Stahl, Tonawanda, N. Y.; Lillie M. Stahl administratrix of said Frank E. Stahl, deceased.

For use in conjunction with farm and road working implements having large pneumatic tires, this cross chain is formed of two chains having their ends connected and their links interlaced, the links being of large size and made from wire of relatively small gauge, whereby the chain will be flexible and readily conform to the tire without injury under working conditions.

For Information
Regarding
The Wire Association
Address
Richard E. Brown, Secretary
17 E. 42nd St., New York, N. Y.

'Round the World With the Wire Industry

German Notes

THE German wire machinery industry reports the demand is very heavy for all grades of modern wire machinery. Although the demand is chiefly reported from domestic markets, there are also important export orders for wire machinery to be noted, particularly for fencing wire, drawing machines and machines for making hexagonal and square wire netting, whereas wire nail machines are less in demand.

✦ ✦ ✦

ARGENTINE, Uruguay and South Africa are the main buyers of varnished (laquered) binding wires, but in other markets too the demand is improving, particularly in the Near East and Italian East Africa, where such wires had not been bought previously. Sizes most in demand are 14 and 16 S. W. G. in coils of ½ cwt., or 25 kilos. The Straits Settlements and India, which had bought very small quantities of these wires heretofore, are now participating in the business.

✦ ✦ ✦

THE final agreement with the Dutch wire industry concerns so far only the domestic Dutch market, which is divided between the Dutch and the Belgian-German industry. The export question so far has only been settled as concerns the wire netting trade, but the others will soon be regulated.

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ONCE again the question of the establishment of an international wire mesh cartel. It appears that almost all the countries exporting are at present interested in the establishment of such a cartel. The difference in qualities, sizes, etc., however, are a great obstacle to the establishment of a cartel controlling price and order. Therefore in German opinion it is not very probable that the establishment will take place. Prices for all qualities of wire mesh are at the moment rather firm, the demand for soft laquered mesh being greater than that for enamelled.

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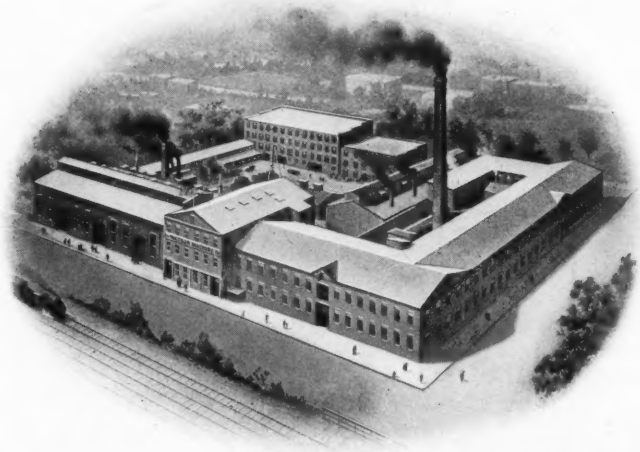
THE final extension of the international wire rod cartel is definitely established, though — at the time of writing—details of the extension were not yet available. The price of £ (gold) 5. 2. 6 to 5. 5. 0 is not undersold. The German export figure has been 4300-4700 tons monthly during the second and third quarter of this year, which is small compared with the output (115.000 t. average). The demand for heavy wire rods is also improving, particularly in the sizes ½" and ⅜". China and Japan are both buying.

(*Please turn to Page 688*)

THE WATSON MACHINE COMPANY

ESTABLISHED 1845

PATERSON, NEW JERSEY, U. S. A.



ENGINEERS MACHINISTS

MANUFACTURERS OF

ELECTRICAL WIRE & CABLE, WIRE ROPE, CORDAGE & GENERAL MACHINERY

YOUR INQUIRIES ARE INVITED

Audit of Employe Opinion Reveals Weak Points in Worker Morale

INDUSTRY must "open new doors between management and men" if employe morale is to be improved in the United States, E. B. Roberts, an authority on industrial relations, told more than 500 representatives of business at the American Management Association's Conference on Office Management.

✦ ✦ ✦

MR. ROBERTS, who is assistant to the vice president of the Westinghouse Electric & Manufacturing Company, based his assertion on an "audit of employe morale" conducted among 2,500 employes of a Western Pennsylvania concern. This is what the audit, conducted by an independent agency to insure secrecy of the individuals' opinions, disclosed to the company:

"1. That it should make promotions more carefully.

"2. That it should watch out for favoritism.

"3. That it has been ineffective in informing employes.

"4. That it should restudy its work in definition of jobs, positions and organization line.

"5. That it is placing too much emphasis on tangibles and neglecting intangibles—that material things alone are not enough, wages and laws and working conditions are not everything —that workers want psychological satisfactions as well as material satisfactions."

✦ ✦ ✦

THE audit disclosed that "the strongest influence on general satisfaction is the opportunity for an individual to do the kind of work he would like to do, that the things most injurious to his morale are those which prevent doing good work." The speaker continued:

✦ ✦ ✦

"THE report emphasized the necessity of fairness and also the need for agreement on what the elements of fairness are by a study of organization and individual jobs—the putting down accurately, in writing the nature of the jobs. In addition to these points it showed the desire, though unexpressed, on the part of the individual, to be treated as an individual on the basis of his merits and the worth of what he is able to do."

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AS disclosed by the series of questions in the audit, only about 41 per cent of the workers thought that no department was favored more than others. Thirty per cent thought that they were judged more by the quality than by the quantity of their work, 37 per cent reported they never received contradictory or conflicting orders, only 39 per cent thought they received pay increases when deserved.

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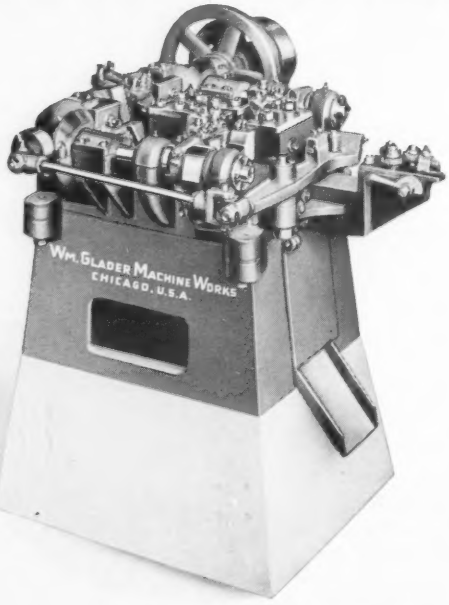
"DO these expressions of opinion indicate the need of a more extensive job analysis to insure that comparable demands, both physical and mental, are met with comparable pay?" asked Mr. Roberts. "Do they prompt more careful and effective salary and rate reviews and a more thorough dissemination of information about them? Do they show the need for attention to the correction

700 NAILS PER MINUTE

GLADER BRAD AND FINE NAIL MAKING MACHINE



This machine will produce nails and brads ¼" to 1⅛" in length from wire 22 gauge to 16 gauge inclusive.

The Glader machine is made in eleven different sizes. This enables us to cover any size of nail most efficiently.

For prices and further information address,

Wm. Glader Machine Works

210 No. Racine Ave.,
CHICAGO, ILLINOIS.

of hazy authority and responsibility lines?"

✦ ✦ ✦

DESPITE these adverse percentages, the speaker said, this report showed that the general satisfaction of employes at the audited plant was above the average of organizations in which parallel studies have been made.

✦ ✦ ✦

RAISING the question whether such expressions of opinion by employes on management "contain an element of danger in stirring up trouble," Mr. Roberts concluded:

"I should say not—indeed quite the opposite. If the dissatisfactions are there, they will be brought out. Natural hesitations that would exist in discussion with management are out of the way. Employes talk here as they would talk to one another. Actually the program is a wholesome morale builder, because it provides the opportunity to unload, to get things off their chest, and make expression safely of attitudes that they would never have the opportunity to voice in the ordinary course of events.

✦ ✦ ✦

"AN objective audit of employe morale and attitudes can be helpful and stimulating to management as well. Management may try to give its people every possible consideration and may feel that its policies are fair and liberal. Yet it is extremely difficult to know just how these policies are regarded by the workers. No matter how well intentioned a policy may be, it is only as good as the employes think it is."

✦ ✦ ✦

Rayotube Detectors

REMARKABLE progress has been made in protecting furnace roofs from overheating, since Rayotube detectors were first applied to the job. Rayotube can now be sighted through a hole in the back-wall directly on the inside of the roof—or, as originally, downward on a target-brick cemented into the roof. To indicate and record roof temperature, and to guard automatically against burnout, either a strip-chart or a round-chart Micromax controller is now being used. And in some mills, this equipment is even holding the furnace automatically at specified working temperature.

✦ ✦ ✦

SO that anyone interested may have information regarding these new developments, the Leeds & Northrup Company has issued a revised edition of their bulletin—"Temperature-Limit Control for Furnace Roofs." For a copy, simply address the company at 4934 Stenton Avenue, Philadelphia, Pennsylvania, and ask for Bulletin N-33B-600B.

Manufacturers of materials, tools and equipment for wire drawing and forming plants are constantly making improvements and additions to their lines. If you do not find the product or service in which you are interested, additional information will be supplied promptly. Simply address:

WIRE & WIRE PRODUCTS
17 East 42nd Street, New York City

WITH BUSINESS IMPROVING
AND
INVENTORIES LOW
SUPPLIER-COOPERATION
IS
IMPORTANT

WE HAVE STEEL IN STOCK
FOR VERY PROMPT
SHIPMENTS
IN
ALL I.P.C.E.A. SIZES OF

STEVENS FLANGED STEEL DRUMS

Made in Low Carbon Steel for Standard Weight and in High Carbon and Alloy Steels for Special Light Weight Drums.

Galvanized — Painted — Plain Finishes

THE STEVENS METAL PRODUCTS COMPANY
NILES, OHIO

Torrington Advertisement In Wire and Wire Products Selected As Prize Winner

The advertisement of the Torrington Manufacturing Co., reproduced below, which first appeared in the July issue of WIRE AND WIRE PRODUCTS, has been selected to appear in a collection of Best Advertisements of the Year picked by an impartial jury of advertising experts. Writing in "Advertising and Milline Data", a quarterly publication devoted to the interests of national advertising, Editor Benjamin Jefferson makes this comment pertaining to the Torrington advertisement: "This message in WIRE AND WIRE PRODUCTS is extremely impressive . . . To thoroughly awaken business circles to the knowledge that a new standard in a fundamental article is at hand is a constantly recurring problem. This advertiser will gain confidence by his conservative attitude marked as it is, by a glance into the world of tomorrow."

The Torrington Manufacturing Company, Torrington, Conn., makers of special machinery since 1885, has achieved marked success with its new line of spring making equipment which comprises Segment and Clutch type Coilers in nine sizes and Torsion Spring Winding Machines in three sizes.

Unique architectural forms at the 1939 New York World's Fair Site dramatize modernism and the World of Tomorrow

INCREASE PRODUCTION — AND PROFITS

Torrington new high speed, Timken bearing equipped spring coiling machines have established a new era in high speed production of coil springs — are modern — pre-eminent in their field — include patented features and improvements of great significance to spring makers. A new bulletin describes in detail Torrington Spring Making equipment — MACHINES WHICH ARE REVOLUTIONIZING PRESENT-DAY SPRING PRODUCTION. Write TODAY.

Spring Making Machines by

TORRINGTON

THE TORRINGTON MANUFACTURING COMPANY
TORRINGTON, CONNECTICUT • • • U. S. A.

'Round The World With The Wire Industry

(*Continued from Page 685*)

IN the export market the improvement is maintained, particularly the trade in Latin America, the Near East and the Mediterranean, whereas with South Africa business is weaker. No change of prices of any importance is reported. China is buying as well as Mandschukuo. The export restrictions in Japan are not of much influence on the general business conditions because the Ministry of Commerce and Industries is granting liberal exceptions. American competition is still felt, although prices are less affected by cutting. Wire nails are lower than fencing wire. Barbed wire exports are restricted from all continental countries. Demand for cable and wire ropes is satisfactory. Wire rope prices are slightly lower.

✦ ✦ ✦

Scomet Engineering Company

THE **Scomet Engineering Company** has taken over the work formerly carried on by the Oxygen-Free Copper Department of the **United States Metals Refining Co.** There will be no change in the method of conducting the business, and this office will continue to deal with all technical matters pertaining to oxygen-free copper.

STEEL WIRE

By MAURICE BONZEL

Translated and Published by
Kenneth B. Lewis
Consulting Engineer

Price $15.00

495 pages. 414 illustrations

SEND ORDERS TO

WIRE and WIRE PRODUCTS

RCA Wire Stiffness Tester

METALS are widely used in industry because they possess a variety of properties which are particularly useful in the fabrication of the articles of commerce. These properties can be varied by mechanical or thermal operations to make the metal more suitable for a specific application. In order to ascertain the effect of these mechanical and thermal operations and assure uniformity in the resultant metal, testing methods have been developed. The more important properties, such as tensile strength, elongation, impact strength, and electrical conductivity are determined by methods that are fairly well standardized because they have been in use for some time. Other properties such as stiffness are more difficult to evaluate and methods of testing have not been standardized.

+ + +

ABOUT seven years ago, it became apparent that the stiffness of wire used in the electrical industry was an important property and that a standard method of testing was badly needed. At that time, the research laboratories of several large corporations began work on this problem and built a number of machines which measured the resistance offered by the wire in bending it through a substantial angle. Later, the American Society of Testing Materials formed a committee to study this problem in connection with tests on materials used in the electrical and radio industry. Three methods were proposed and described in the annual report of 1936, and early in 1938 the committee decided upon a method for testing wire which it proposes to standardize.

+ + +

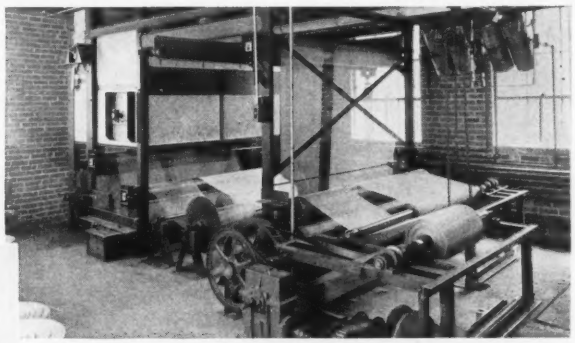
RCA Wire Stiffness Tester

FOLLOWING is a description of the **RCA Wire Stiffness Tester** that has been in development and use in the RCA Co., Inc. factories and laboratories for several years and has recently been developed to such a high degree of mechanical accuracy, that it is considered that it will prove to be

(*Please turn to Page 690*)

Manning Insulation Papers
Preferred By The
Electrical Industry for 40 Years
Industrial - Technical Use
Since 1846
John A. Manning Paper Co. Inc.
Offices Factories Laboratories
Troy, N. Y.

TOWER OVEN



DRYING WIRE SCREEN CLOTH

The top roller is so high in the tower the wet cloth does not pass over it until the coating is reasonably set. Although the tower is high, but little floor space is required below.

Write for our FREE 44 page catalog!

AMF Crawford INDUSTRIAL OVENS

AMERICAN MACHINE & FOUNDRY CO.
CRAWFORD OVEN DIVISION
200 SHELTON AVE. NEW HAVEN, CONN.

Valve replacement - a tax that can be reduced

Replacement of valves because of corrosion is expensive.

There is the cost of new valves, the payment for labor, the loss of time and the value of the lost production. These are direct costs that can be reduced.

Put Duriron valves on your acid-handling lines and those losses and outlays are reduced to the minimum. Duriron valves are made especially for the handling of corrosive liquids. They are resistant not only to acid corrosion but also to erosion.

Duriron valves save money . . . time out for repairs . . . loss of production — all good reasons why Duriron valves should be on your acid lines.

Bulletin No. 601-A, in which Duriron valves are illustrated, will be sent on request.

THE DURIRON COMPANY, Inc.

445 N. Findlay St. Dayton, Ohio

Announcement of New Type Flash Baker

THE Carl-Mayer Corp., 3030 Euclid Ave., Cleveland, Ohio, have just issued bulletin RB-38 describing their most recent development in rod baker design.

✦ ✦ ✦

THEY have named this new type of baker the **Carl-Mayer Hi-Speed Rod Baker** and state that they meet the problem of excessive condensation at top of coils which makes the coil slow to dry, and causes rusting, by reversing the existing cold air curtain principle and recirculating from a specially designed slot around the perimeter of the baker top, they claim that with this design they accomplish two things:

(1) **Form a "hot" air curtain or semi-"heat seal" across the top instead of the customary "cold" air curtain.**

(2) **Prevent a "cold" air strata at the top, thus preventing condensation during the drying process.**

✦ ✦ ✦

IT is further stated in connection with this baker that by providing a high pressure blower and special high pressure velocity blow nozzles at the bottom of the baker the excessive moisture collection at the bottom of coils is quickly removed in conjunction with the general drying system furnished. Another feature claimed is that the Large Air Volume upwards of 10,000 c. f. m. is directed through the suspended coil at high velocity instead of the customary small volume, as rate of drying is proportional to air volume and temperature giving an approximate baking speed 6 to 15 minutes per pin.

This is an invitation for you to become a member of The Wire Association. ✦ ✦ ✦ ✦ ✦ ✦

The Annual Dues are $10.00

For Details Address

Richard E. Brown, Secretary

The Wire Association

17 E. 42nd St., New York, N. Y.

R. C. A. Wire Stiffness Tester

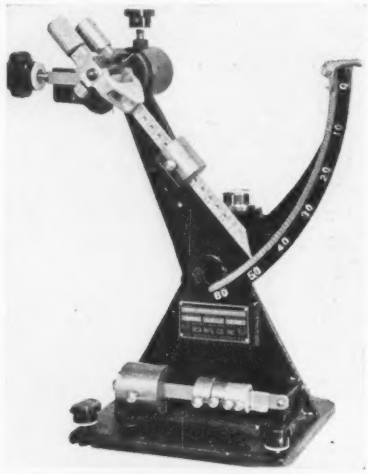
(*Continued from Page 689*)

a necessary precision instrument to the trade.

✦ ✦ ✦

THE **RCA Wire Stiffness Tester** as shown in the illustration, will measure the stiffness of wire from 0.015″ to 0.100″ in diameter. It may also be used in measuring the stiffness of strip up to ⅜″ wide and .050″ thick depending upon the nature of the material. The angle through which the wire can be bent is 60°. This tester has been designed to given sensitivity without sacrifice of ruggedness, together with ease and convenience in testing. On this account, accurate readings are made very rapidly.

✦ ✦ ✦



Principle of the Tester

IN principle, this tester applies a load to the specimen supported as a cantilever beam and bends it through an angle. The load is applied to the specimen at a distance of 1 cm if the wire is .040″ or less in diameter and at 2 cm for larger wire. The amount of the load is adjusted by using various sizes of weights which can be fastened at 1 cm intervals on a horizontal beam. The size of the weight and its position are selected so that when the beam is released and allowed to fall, it comes to rest somewhere on the scale, usually between 30° and 60°. The final position is a measure of the stiffness of the wire because as the wire is being bent by the load, it increases its resistance due to the

cold working effect of the bending. At the same time as the beam drops, the force it can exert on the wire diminishes as the cosine of the angle and finally reaches a value equal to the resistance offered by the wire, and the beam comes to rest.

✦ ✦ ✦

SINCE the stiffness of the wire is increased by flexing the wire, it is important that the specimen is not bent in handling it and placing it in the tester. Furthermore, if the specimen is not in contact with the loading edge, the beam will drop freely before striking the specimen and drop too far, or if the specimen is sprung by the loading edge when being clamped, the beam will not drop as far as it should. Consequently, the clamping jaws are mounted so that they can be rotated about the axis of the beam pivots, allowing the specimen to be brought into contact with the loading edge without springing the wire and without requiring straightening.

✦ ✦ ✦

THIS tester is portable, and can be set up and balanced on any reasonably level table or bench. Tests on crooked or curved wire can be made conveniently with accuracy. The load can be varied from 6 to 8000 g - cm. Tests both wire and narrow strip up to 60° of bend. The scale is easily read without fatigue.

✦ ✦ ✦

High Pressure Hydraulic Pumps

JUST issued by John Robertson Company, a new bulletin on Robertson High Pressure Hydraulic Pumps.

✦ ✦ ✦

THIS bulletin, a convenient file-size folder, contains a detailed description of the construction of these pumps (including the "14 famous advantages" designed to lower operating and maintenance costs); incorporates a complete reference table of general dimenssions and specifications. Copy may be obtained free by writing Dept. 8 of the John Robertson Company, 133 Water Street, Brooklyn, N. Y.

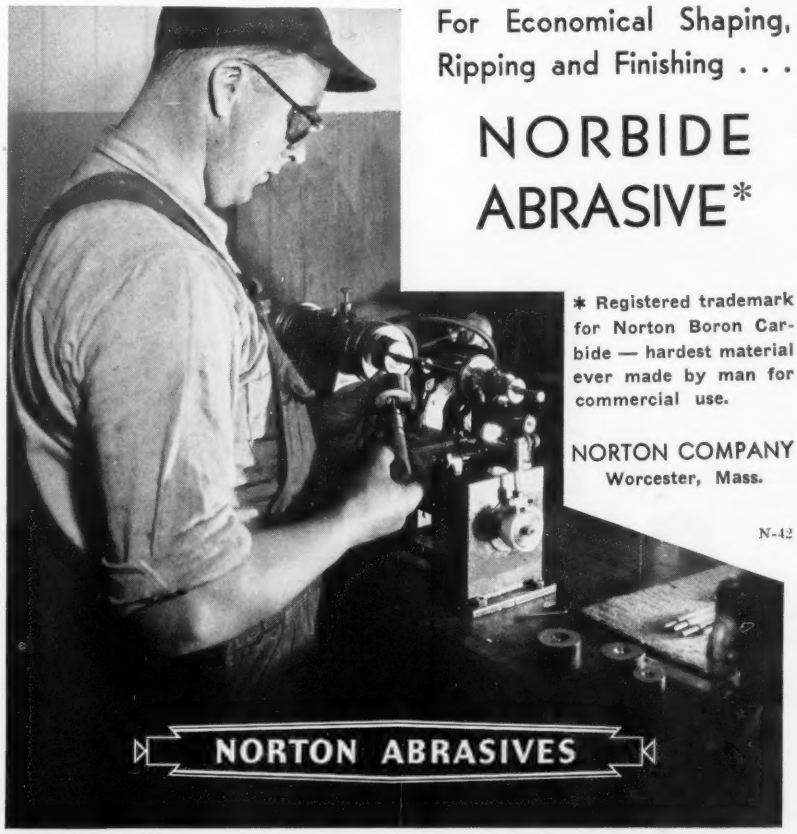
Today
In Wire Drawing Processes
Bell-Mine Pulverized Lime
is used by
Many Leading Wire Producers

UNIFORM PURITY OF BELL-MINE LIME
IS ASSURED BECAUSE

1st. The limestone mined from the deep, pure Bellefonte vein, 650 ft. below ground is kept free of surface dirt and foreign stone by all-mechanical handling, mine to crusher and crusher to rotary kiln.

2nd. All processing steps are under constant engineering supervision. Both raw stone and finished burned lime from the large, modern rotary kilns are continually analyzed and tested for quality-uniformity by trained chemists in Warner Laboratory at the Plants.

Warner Company
BELLEFONTE DIVISION
SALES OFFICES: PITTSBURGH, PHILADELPHIA, BELLEFONTE, N. Y. CITY.



For Economical Shaping, Ripping and Finishing . . .

NORBIDE ABRASIVE*

* Registered trademark for Norton Boron Carbide — hardest material ever made by man for commercial use.

NORTON COMPANY
Worcester, Mass.

N-42

TUNGSTEN CARBIDE

DIES BY WILLEY'S

Tungsten Carbide of special grade developed in our laboratory and covered by U. S. Patents.

Standard sizes in stock.

Special sizes or shapes on order.

Prices Quoted Upon Request

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CARBIDE TOOL CO.
MANUFACTURERS AND SPECIALISTS IN
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High Speeds
Long bearing Dies
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FAMOUS
WIRE DRAWING DIAMOND DIES

VIANNEY

250 E. 43rd St. • New York

Largest Stocks in U.S.A.
Quickest Deliveries
Safest Guarantees
Best Selections
Lowest
Costs

The Development of High Strength Electrical Conductors and Messenger Cables

(*Continued from Page 670*)

that its fatigue limit is 29,000 lbs. per sq. in. Further cold drawing would raise the fatigue limit a few thousand pounds per square inch. in other words, the fatigue resistance of Calsun Bronze is from two to three times that of copper.

✦ ✦ ✦

General Conclusions

A STUDY of the foregoing data covering some thirteen years of development and proof-testing gives us a very sound basis for selecting Calsun Bronze for high-strength, corrosion-resisting wire and cable.

✦ ✦ ✦

(1) By reason of the facility with which the Calsun Bronze castings can be processed into wire by hot rolling and cold drawing, a product is obtained that is both uniform in quality and moderate in cost.

(2) Compared with hard-drawn copper, Calsun Bronze has more than twice the tensile strength, two to three times the fatigue limit and a high order of ductility.

(3) Calsun Bronze has a conductivity of 17% which is the highest thus far obtainable in a bronze of this character. Since in railway electrification the messenger is always a part of the current-carrying system, this property has an appreciable value.

(4) Its corrosion-resisting qualities are demonstrated to be second only to pure copper, while its resistance to a particularly severe combination of atmospheric corrosion and stress has been proven in several tests.

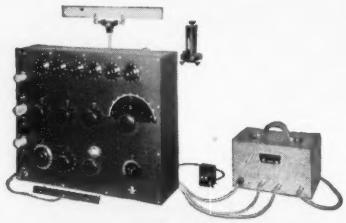
✦ ✦ ✦

Applications

IN many cases, copper wires are added to Calsun Bronze strands to increase the current-carrying capacity of the cable. Four types of installation are illustrated in Figs. 5 to 8. As a messenger for carrying lead-covered telephone or telegraph cable through tunnels or corrosive atmospheres, Calsun Bronze has found wide use. It is employed for cross-span wire, guy wire, for long spans in transmission lines at river crossings, and for rural electrification. Its high quality and engineering properties have been established by thorough investigation and by long industrial service.

✦ ✦ ✦

Acknowledgement is made of the permission of The American Brass Company to publish the results of tests, and of the co-operation and helpful suggestions of the late H. C. Jennison, Technical Manager of The American Brass Company.



1511 L&N Modified Schering Bridge

CABLE INSULATING MATERIALS ACCURATELY TESTED

For accurate measurements of power factor and specific inductive capacitance of oils, rubber, varnished cambric, paper, etc., cable manufacturers use the L&N Schering Bridge. This compact, easily operated bridge is also suitable for testing small samples of completed cable.

All adjustable elements are confined within a grounded shield to protect operator and to assure accuracy. High voltage is applied only to test sample and to standard air capacitor. Capacitances from 40 micro-microfarads to 0.02 microfarad and power factors from 0.0001 to 0.7 can be accurately determined.

Write for Catalog E.54 (2)

LEEDS & NORTHRUP COMPANY
4974 STENTON AVE., PHILA., PA.
LEEDS & NORTHRUP
MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

AD E54-460 (4)

WHOEVER UNDERSTANDS GERMAN

Should Read

'Draht-Welt"
(Wire World)

A weekly for the wire industry and related lines.

Subscription price: Rm. 6.50 quarterly

Sample copies free on request from:

Martin Boerner — Verlag
Halle — Saale
Germany

A. S. M. E. New Officers

THE American Society of Mechanical Engineers announces the election on September 27th, 1938 of the following new officers for 1939 who will assume office on December 9, 1938:

President

Alexander G. Christie, Prof. M. E., Johns Hopkins University, Baltimore, Md.

Vice-Presidents

Henry H. Snelling, Senior Member, Snelling & Hendricks, Washington, D. C.

Wm. Lyle Dudley, V. P. Charge Design & Sales, Western Blower Company, Seattle, Wash.

Alfred Iddles, Application Engr., Babcock & Wilcox Company, New York, N. Y.

James W. Parker, V. P. and Ch. Engr., Detroit Edison Company, Detroit, Mich.

Managers

Clarke Freeman, V. P. Charge Fire Prevention, Engrg. & Underwriting, Manufacturers Mutual Fire Ins. Co., Providence, R. I.

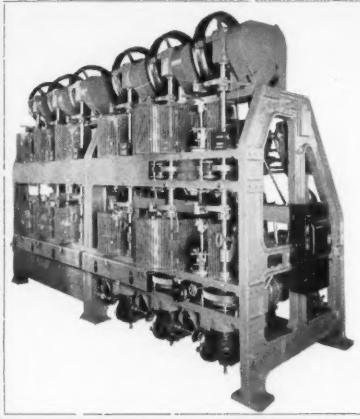
William H. Winterrowd, V. P., Franklin Railway Supply Co., Chicago, Ill.

Willis R. Woolrich, Dean of Engrg., University of Texas, Austin, Texas

Manufacturers of materials, tools and equipment for wire drawing and forming plants are constantly making improvements and additions to their lines. If you do not find the product or service in which you are interested, additional information will be supplied promptly. Simply address:

WIRE & WIRE PRODUCTS

17 East 42nd St. New York City



AIMCO

3Q6-T-MBB TAPING MACHINE
Ball Bearing
Each Unit Individually
Motor Driven
for application of four paper tapes to each of six lines of wire.

EST. 1885 AIMCO INC. 1918
"American" INSULATING MACHINERY COMPANY
REG. U.S. PAT. OFF.
517 West Huntingdon St.
PHILADELPHIA PENNSYLVANIA U.S.A.

PROCEEDINGS

OF THE WIRE ASSOCIATION MEETINGS

▲▲▲

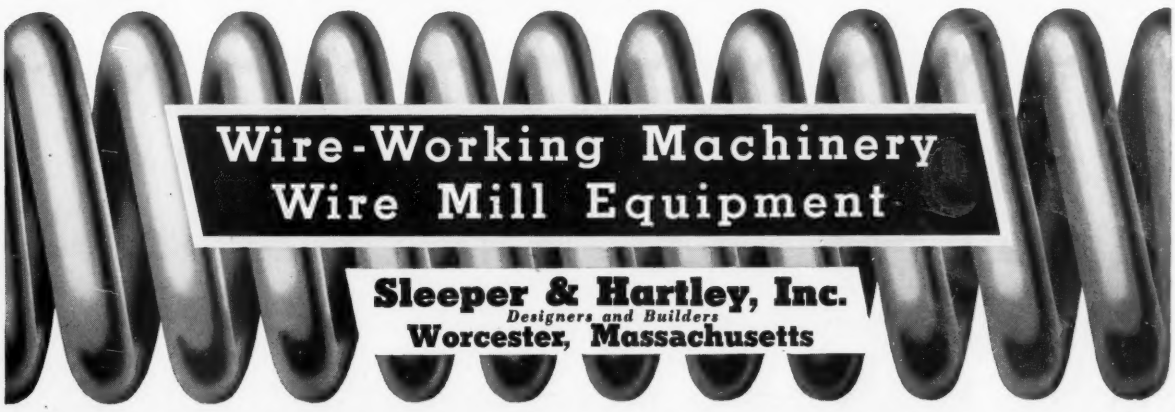
STENOGRAPHIC minutes of the discussions at the Wire Association meetings held at Detroit, Michigan, October 17 to 21, 1938, inclusive, will be published in full in the January, 1939 issue of WIRE & WIRE PRODUCTS.

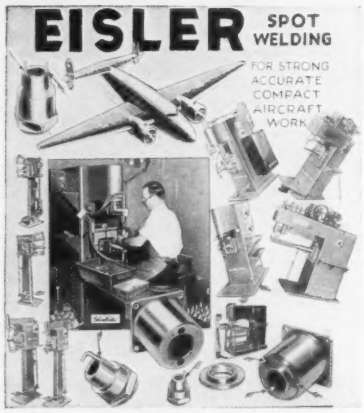
✦ ✦ ✦

MEMBERS of the Wire Association and subscribers to WIRE & WIRE PRODUCTS will receive these proceedings in this manner.

✦ ✦ ✦

OTHERS desiring the proceedings can obtain them either by becoming members of the Wire Association, or by subscribing to WIRE & WIRE PRODUCTS.





"If it's for electric welding, we make it"—from a radio tube filament, .0005" to a door welding.

We manufacture the most complete line of standard and special electric spot welders from ¼ to 500 K.V.A., some as low as $25.00.

We also manufacture special welding transformers to suit your requirements.

Ask for our catalog #38W showing over 1250 interesting illustrations—press type air operated, plunger type foot operated and motor driven, spot, butt, seam, roller and A.C. arc welders and transformers.

Send us your welding problems for quotations.

We manufacture a very complete line of welding tips and water-cooled electrode holders for difficult welding jobs.

We also do Job Spot Welding.

EISLER ENGINEERING COMPANY,
Incorporated
762 S. 13th St., near Avon Ave.,
Newark, New Jersey

ONE PIECE
AS LARGE AS 6' WIDE
6' DEEP — 9'6" LONG

ACID RESISTANT
UNAFFECTED BY HYDROCHLORIC, ANY CONC. SULPHURIC UP TO 50% CONC.

UNAFFECTED BY TEMPERATURES UP TO 265° F.

PICKLING--PLATING TANKS

OF MOLDED PHENOLIC RESIN ASBESTOS COMPOSITION—THEY ARE STRONG, TOUGH, DURABLE. SEND FOR BULLETIN WD1.

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STEELSKIN
REG. U. S. PAT OFFICE
For High or Low Carbon Wire
WIRE DRAWING SOAPS
Established 30 years
R. H. MILLER CO., Inc. Homer, N. Y.

VIANNEY
offers you
a NEW, LATEST type of Diamond Die, just now on the market besides the usual regular type. Write us for information.
VIANNEY WIRE DIE WORKS
250 E. 43rd. St. NEW YORK

Torrington Manufacturing Company Builds Torsion Machine

THE Torrington Manufacturing Company of Torrington, Connecticut, which recently announced an improved and modern line of Segment and Clutch Type Spring Coilers, has now added to its line a Torsion Spring Winding Machine for which the manufacturer claims greatly increased accuracy and speed in the production of torsion springs with complicated end forms either on one or both ends of springs.

✦ ✦ ✦

INCORPORATED in these new Torsion Machines are the following exclusive features:

1. **Ample time for forming under a new patented principle.**
2. **Provision for mounting tools to form either or both ends of springs.**
3. **Spindle in horizontal plane.**
4. **Readily accessible forming tools.**
5. **Quick adjustment of feed, number of coils, pitch, spindle stop, arbors and cams.**
6. **Timken Bearing equipped.**
7. **Spindle gears running in oil bath.**
8. **Either slide or roll wire feed for effecting greater accuracy of first ends of springs.**

✦ ✦ ✦

THE line includes machines in three sizes covering a range from .008" to .135" diameter wire. The company is prepared to supply all necessary tooling and attachments for any requirements within the range of these machines.

✦ ✦ ✦

Magnus Vapor Cleaner

MAGNUS Chemical Company, Inc., has just issued a new descriptive folder on its new product, Magnus Vapor Cleaner.

✦ ✦ ✦

MAGNUS Vapor Cleaner is made to give the greatest effectiveness and speed to steam or vapor cleaning, combining the principles of soap washing with solvent cleaning. The combination of the two results in faster and more thorough "cutting" action than is found when either is used alone.

✦ ✦ ✦

THIS new product is offered in two grades—Magnus 92-E for light duty cleaning; Magnus 94-E for heavy duty cleaning. Both are light brown pastes, quickly and readily soluble in water. They im-

part to the water a wetting, penetrative and solvent effect beyond that of any soap or alkali.

✦ ✦ ✦

THIS cleaner is guaranteed to function satisfactorily in any make of steam or vapor cleaning machine, such as the Hy-Pressure Jenny, the Kerrick Kleaner, the Circo Cyclone Cleaner, the Ofelt, the Eclipse and the Star. Your copy of this new folder can be obtained by writing to the Magnus Chemical Company, Inc., Garwood, New Jersey.

✦ ✦ ✦

Weld-O-Trol — An Ignitron A-C. Welding Contactor — Without Timing

A 4-PAGE illustrated booklet published by Westinghouse Electric & Manufacturing Company announces a new Weld-O-Trol electronic power switch for controlling the primary of welding transformers and suitable for use with existing timing devices and for welding mild steel products and other readily welded metals.

✦ ✦ ✦

AS an approximation, the WL-652 and WL-657 tubes give a rating for spot welding approximating that of a 300 ampere contactor, while the WL-651 and WL-656 tubes roughly approximate the rating of a 600 ampere contactor. The rating of the continuously pumped Weld-O-Trol is such that it will handle applications previously almost impossible because of difficulty of switching the welding machine current.

✦ ✦ ✦

COPIES of this booklet, Descriptive Data 18-345, may be secured from the nearest district office of Westinghouse Electric & Manufacturing Company, or from headquarters at East Pittsburgh, Pennsylvania.

For Information
Regarding
The Wire Association
Address
Richard E. Brown, Secretary
17 E. 42nd St., New York, N. Y.

Learn about PARALAN

Paralan will give your finished wire and wire products protection from atmospheric corrosion in the mill and in shipping. Paralan-coated wire can be spot welded or soldered without cleaning. Also, Paralan leaves surfaces in good condition for all types of finishes—enameling, japanning, lacquering, plating, etc.

Write for further information. We may be able to solve your difficulties.

AMERICAN LANOLIN CORP.
LAWRENCE, MASSACHUSETTS

CARBOLOY
WIRE STRAIGHTENING DIES

USERS REPORT
3 Years Continuous Service
On Steel Rod
With No Appreciable Wear

Equip your present wire straightening and cutting machines with Carboloy dies.

Write for information regarding your particular application.

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Flexible Gas Annealer for Wire

COMBINING a new uniformity of product, reduced cost and the unique flexibility which gas alone can offer, a new type of gas furnace known as the Square Bell Annealer has recently been installed at the plant of the Wilson Steel & Wire Co., Chicago. The wire, in charges varying from 8000 to 14,000 lbs. in weight, is placed on 4 spindles on a base. An inner cover is placed over the wire and the annealing bell, with the gas burners is placed over all by crane. When up to the heat the outer cover is removed and transferred to another base. A non-oxidizing atmosphere is preserved about the wire, while cooling by the inner cover. The Peoples Gas Light & Coke Co., Chicago, cooperated in making this installation.

Exports and Imports of Wire

(*Continued from Page 682*)

were supplied by Germany 14,814 square feet; Sweden 4,441 square feet; and France 772 square feet.

✦ ✦ ✦

EXPORTS of iron and steel wood screws during August, 1938 totaled 12,102 gross valued at $2,824. Of this total Venezuela took 2,956 gross valued at $538; Chile 1,610 gross valued at $123; Colombia 1,406 gross valued at $267; Argentina 1,303 gross valued at $988; Panama 1,229 gross valued at $217; Haiti 900 gross valued at $112; Mexico 674 gross valued at $97.

✦ ✦ ✦

EXPORTS of brass wood screws during the same month totaled 7,561 gross valued at $2,058. Of this total the United Kingdom took 3,705 gross valued at $308; the Panama Canal Zone 782 gross valued at $483; Cuba 546 gross valued at $382; Chile 500 gross valued at $103; Venezuela 455 gross valued at $155; Honduras 400 gross valued at $71; Panama 386 gross valued at $122.

✦ ✦ ✦

IMPORTS of wood screws during the same month totaled 29,855 gross valued at $1,826. Of this total Belgium supplied 25,170 gross valued at $1,481; Japan 2,000 gross valued at $173; Italy 1,700 gross valued at $154; and Germany 985 gross valued at $18.00.

✦ ✦ ✦

CARD CLOTHING receipts totaled 11,276 square feet valued at $19,497 against 11,457 square feet valued at $20,195 and came from the United Kingdom (9,142 square feet valued at $15,201), Belgium (2,049 square feet valued at $3,847); and Germany (85 square feet valued at $449).

✦ ✦ ✦

RECEIPTS of WIRE HEDDLES totaled 161,000 pieces and were supplied from France 132,000 pieces and Switzerland, 29,000.

GEORGE D. HARTLEY
CONSULTANT
311 MAIN ST.,
WORCESTER, MASS.

• PLANT EQUIPMENT PRODUCTION METHODS • AUTOMATIC MACHINERY

• MARKETING OF LATEST PATENTS, INVENTIONS • AND PROCESSES

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3—Nilson No. 1, 2, 3 & 4 4 Slide Wire Machines
2—Baird No. 3 & S3F 4 Slide Wire Machines
7—Waterbury Step Cone Wire Drawing Machines
1—24-16" Block Wire Drawing Machine
8—Shuster Automatic S. & C. Machines 1/32", 1/8", 3/16", 1/4", 5/8", 1/2", also 1/2", 7/8" square wire, motor driven.
Wanted: Wire Spring making machinery.

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FOR SALE

BELLIS Salt Annealing equipment for annealing rods and wire.

THE SENECA WIRE & MFG. CO.
FOSTORIA, OHIO.

A TRADE OF 35,398 square feet resulted in WIRE CLOTH AND SCREEN against 23,862 square feet and came from Germany 19,308 square feet; Canada 8,952 square feet, the Netherlands 3,753 square feet; and Japan 3,385 square feet.

✦ ✦ ✦

RECEIPTS OF WIRE FENCING AND NETTING, galvanized before weaving, amounted to 33,500 square feet from France. Of that galvanized after weaving, the total was 2,128,650 square feet as against 1,848,910 square feet and came from the Netherlands 1,485,400 square feet, Germany 638,250 square feet and the United Kingdom 5,000 square feet.

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STRAIGHTENING AND POLISHING MACHINES
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for round and shaped wire.
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THOMASTON CONNECTICUT

Nilvar Alloy for Precision Radio Applications

BECAUSE of its relative immunity to size changes with temperature variations over a wide range, Nilvar, a trade-marked nickel-iron alloy produced by the Driver-Harris Co., Harrison, N. J., is finding important applications in present-day radio.

✦ ✦ ✦

WITH the lowest coefficient of expansion up to 392° F., Nilvar is used for parts where constancy of dimensions must be maintained. Already popular in the manufacture of bimetallic strip, measuring tapes, length standards and for other similar requirements, this alloy is now popular in radio tubes wherein low expansion members are desired particularly in maintaining frequencies within very close limits. In the form of rotor and stator plates of variable condensers, Nilvar is being used in ultra-high-frequency equipment where the slightest variation in dimensions or positioning would mean the serious detuning of signals.

The Proceedings of the Wire Association Annual Technical Convention will be published in full in the January, 1939 issue of WIRE & WIRE PRODUCTS.

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Round Wire Straightening and Cutting Machinery
Flat Wire Straightening and Cutting Machinery
Roll and Rotary Wire Straighteners
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Straightener Specialists Since 1866

Index to Advertisers

A

Aetna-Standard Engineering Co. 647
American Chemical Paint Co. 696
American Insulating Machinery Co. 693
American Lanolin Co. 695
American Machine & Foundry Co., Crawford Oven Div. 689

B

Bethlehem Steel Company 648
Broden Construction Co. 697

C

Carboloy Company, Inc. 645
Carl-Mayer Corp., The 649
Cochaud Wire Die Corp. 697

D

Duriron Company, Inc., The 690

E

Eisler Engineering Co., Inc. 694
Electric Furnace Co., The ..... Back Cover

F

Fidelity Machine Co. 697
Firth Sterling Steel Co. 654

G

Glader, Wm., Machine Works 686

H

Hallden Machine Co., The 697
Hartley, Geo. D. 696
Haveg Corp. 694
Hudson Wire Company 651

K

Kelly Wire Die Corp. 697
Keystone Steel & Wire Co. 683

L

Lancaster, Allwine & Rommel 695
Leeds & Northrup Co. 692
Lewis, K. B. 696
Lewis Machine Co., The 695

M

Magnus Chemical Co. 696
Manning Paper Co., Inc., John A., ... 689
Master Wire Die Corp. 652
Metal Industry Works 697
Micro Products Co. 682
Miller, R. H. Co., Inc. 694
Morgan Construction Co. ..... Inside Back Cover

N

National Machinery Exchange 696
Norton Company 691

P

Pittsburgh Steel Company 646
Platt Brothers & Co. 697

R

Robertson, John, Co., Inc. 684
Royle, John, & Sons 697
Ruesch Machine Co., H. J. 697
Rusch Wire Die Corp. 695

S

Schein Bros. Ltd. 697
Schuyler, W. A. 697
Scudder Foundry & Machine Co., E. J. 697
Seneca Wire & Mfg. Co. 696
Shuster, F. B., Co., The 697
Sinfra Corp., ... 697
Sleeper & Hartley, Inc. 693
Stevens Metal Products Co. 687

T

Thomson-Judd Wire Machinery Co. 697
Torrington Manufacturing Co., The 672-673
Twitchell, E. W., Inc. 697

V

Vaughn Machinery Co., The ..... Front Cover
Vianney Wire Die Works 692-694

W

Warner Company 691
Watson Machine Co., The 685
Willey's Carbide Tool Co. 692

Y

Youngstown Sheet & Tube Co., The ..... Inside Front Cover

WHERE TO BUY

For more complete information, consult the annual Directory, Index & Buyers' Guide.

ABRASIVES—
Norton Co., Worcester, Mass.

ANNEALING POTS AND BOXES—
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.

ANTI-RUST—
Magnus Chemical Co., Garwood, N. J.

ARMORING EQUIPMENT—
American Insulating Mach'y. Co., Phila., Pa.
Sleeper & Hartley, Worcester, Mass.
Watson Machine Co., Paterson, N. J.

BAKERS—Rod and Wire
The American Machine & Foundry Co., Carl-Mayer Corp., Cleveland, O.
Crawford Oven Div., New Haven, Conn.
Morgan Construction Co., Worcester, Mass.

BORON CARBIDE—
Norton Co., Worcester, Mass.

CEMENT FLOOR CLEANER—
Magnus Chemical Co., Garwood, N. J.

CEMENTS—Refractory
Norton Co., Worcester, Mass.

CHEMICALS—Cleaning
American Chemical Paint Co., Ambler, Pa.
Magnus Chemical Co., Garwood, N. J.

CLEANERS—Hand and Metal
Magnus Chemical Co., Garwood, N. J.

CLEANING & PICKLING EQUIPMENT—
Broden Construction Co., Cleveland, O.
Duriron Co., The, Dayton, O.
Haveg Corp., Newark, Del.
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

COATING—Protective
American Lanolin Corp., Lawrence, Mass.

COILERS—Sheet, Strip and Wire
Broden Construction Co., Cleveland, O.
H. J. Ruesch Machine Co., Newark, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

CONDUITS—Iron and Steel
Youngstown Sheet & Tube Co., Youngstown, Ohio.

CONTROLS—Automatic
Leeds & Northrup Co., Philadelphia, Pa.

CRANES—Wire Mill
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

DIAMOND TOOLS—
Rusch Wire Die Corp., New York, N. Y.

DIES—Diamond
Cochaud Wire Die Co., New York, N. Y.
Kelly Wire Die Corp., New York, N. Y.
Master Wire Die Corp., New York, N. Y.
Rusch Wire Die Corp., New York, N. Y.
Vianney Wire Die Works, New York, N. Y.
Willey's Carbide Tool Co., Detroit, Mich.

DIES—Lead Extrusion
John Robertson Co., Brooklyn, N. Y.

DIES—Repairs & Re-Cutting
Carboloy Co., Inc., Detroit, Mich.
Cochaud Wire Die Co., New York, N. Y.
Firth-Sterling Steel Co., McKeesport, Pa.
Kelly Wire Die Corp., New York, N. Y.
Master Wire Die Corp., New York, N. Y.
Rusch Wire Die Corp., New York, N. Y.
Vianney Wire Die Works, New York, N. Y.

DIES—Rod and Tube Drawing
Carboloy Co., Inc., Detroit, Mich.
Firth-Sterling Steel Co., McKeesport, Pa.
Kelly Wire Die Corp., New York, N. Y.
Master Wire Die Corp., New York, N. Y.
Rusch Wire Die Corp., New York, N. Y.
Vianney Wire Die Works, New York, N. Y.

DIES—Tantalum Carbide
Carboloy Co., Inc., Detroit, Mich.
Kelly Wire Die Corp., New York, N. Y.
Master Wire Die Corp., New York, N. Y.
Rusch Wire Die Corp., New York, N. Y.
Vianney Wire Die Works, New York, N. Y.

DIES—Tungsten Carbide
Carboloy Co., Inc., Detroit, Mich.
Firth-Sterling Steel Co., McKeesport, Pa.
Kelly Wire Die Corp., New York, N. Y.

WHERE TO BUY, Continued

Master Wire Die Corp., New York, N. Y.
Rusch Wire Die Corp., New York, N. Y.
Vianney Wire Die Works, New York, N. Y.
Willey's Carbide Tool Co., Detroit, Mich.

DRAW BENCHES—
H. J. Ruesch Machine Co., Newark, N. J.
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.
Vaughn Machinery Co., Cuyahoga Falls, O.

DRUMS—Flange Steel
Stevens Metal Products Co., Niles, O.

ENGINEERS—Consulting Wire Mill
Lewis, Kenneth B., New York, N. Y.
Hartley, George D., Worcester, Mass.

EQUIPMENT—Insulation Testing
Leeds & Northrup Co., Philadelphia, Pa.

EYELETS—Brass or Zinc
Platt Bros. & Co., The, Waterbury, Conn.

FILLERS—Paper for Cable
E. W. Twitchell, Inc., Phila., Pa.

FLASH BAKERS—
Carl-Mayer Corp., Cleveland, O.

FURNACE CONTROLS — Combustion
Leeds & Northrup Co., Philadelphia, Pa.

FURNACE CONTROLS—Draft
Leeds & Northrup Co., Philadelphia, Pa.

FURNACES—Annealing
Electric Furnace Co., Salem, O.
Leeds & Northrup Co., Philadelphia, Pa.

FURNACES—Automatic
Electric Furnace Co., Salem, O.
Leeds & Northrup Co., Philadelphia, Pa.

FURNACES—Bright Annealing
Electric Furnace Co., Salem, O.

FURNACES—Electric
Electric Furnace Co., Salem, O.

FURNACES—Hardening and Tempering
Electric Furnace Co., Salem, O.
Leeds & Northrup Co., Philadelphia, Pa.

FURNACES—Lead Melting
Electric Furnace Co., Salem, O.
John Robertson Co., Brooklyn, N. Y.

FURNACES—Non-Oxidizing
Electric Furnace Co., Salem, O.

FURNACES—Normalizing
Electric Furnace Co., Salem, O.
Leeds & Northrup Co., Philadelphia, Pa.

FURNACES—Wire, Strip & Sheet
Electric Furnace Co., Salem, O.

GRINDERS—ROLL
Norton Co., Worcester, Mass.

INHIBITORS—
American Chemical Paint Co., Ambler, Pa.

INSTRUMENTS—Electrical
Leeds & Northrup Co., Philadelphia, Pa.

INSULATION — Cable or Cable Filler
E. W. Twitchell, Inc., Phila., Pa.

LATHES—Die Reaming
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

LIME—Pulverized
Warner Co., Bellefonte, Ohio.

LUBRICANTS—For Metal Cutting, Stamping and Drawing
Magnus Chemical Co., Garwood, N. J.

LUBRICANTS—Wire Drawing
Magnus Chemical Co., Garwood, N. J.

MACHINERY—Armoring (Cable, Wire Hose)
American Insulating Mach'y. Co., Phila., Pa.
John Robertson Co., Brooklyn, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.
Thomson-Judd Wire Machinery Co., Lynn, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Braiding
Fidelity Machine Co., Philadelphia, Pa.
Watson Machine Co., Paterson, N. J.

MACHINERY—Brazing
Thomson-Judd Wire Machinery Co., Lynn, Mass.

MACHINERY—Bunching
American Insulating Mach'y. Co., Phila., Pa.
Sleeper & Hartley, Inc., Worcester, Mass.
Watson Machine Co., Paterson, N. J.

MACHINERY—Bundling, Scrap
Sleeper & Hartley, Inc., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.
Watson Machine Co., Paterson, N. J.

MACHINERY—Cable, Electric
American Insulating Mach'y. Co., Phila., Pa.
Fidelity Machine Co., Philadelphia, Pa.
Thomson-Gibb Electric Welding Co., Lynn, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Chain Making
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Closing
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Coil Winding
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Coilers
Broden Construction Co., Cleveland, O.
Morgan Construction Co., Worcester, Mass.
H. J. Ruesch Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Copper Wire Drawing and Rolling
H. J. Ruesch Machine Co., Newark, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Covering Wire
Sinfra Corp., Jersey City, N. J.

MACHINERY—Cutting
Broden Construction Co., Cleveland, O.
Hallden Machine Co., Thomaston, Conn.
Lewis Machine Co., The, Cleveland, O.
National Machinery Exchange, New York, N. Y.
F. B. Shuster Co., New Haven, Conn.
W. A. Schuyler, New York, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Enameling
American Insulating Mach'y. Co., Phila., Pa.

MACHINERY—Extruding
John Robertson Co., Brooklyn, N. Y.
Royle, John & Sons, Paterson, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Flat Wire
Broden Construction Co., Cleveland, O.
H. J. Ruesch Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Forming
National Machinery Exchange, New York, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Galvanizing Wire
Broden Construction Co., Cleveland, O.
Sleeper & Hartley, Inc., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Gang Winders
Fidelity Machine Co., Philadelphia, Pa.
H. J. Ruesch Machine Co., Newark, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Grinding
Norton Co., Worcester, Mass.

MACHINERY—Insulating
American Insulating Mach'y. Co., Phila., Pa.
Fidelity Machine Co., Philadelphia, Pa.
Sinfra Corporation, Jersey City, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Knitting
Sinfra Corporation, Jersey City, N. J.

MACHINERY—Lead Encasing Presses, etc.
John Robertson Co., Brooklyn, N. Y.

MACHINERY—Lead Stripping
John Robertson Co., Brooklyn, N. Y.
Watson Machine Co., Paterson, N. J.

MACHINERY—Lock Washer
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., Torrington, Conn.

MACHINERY—Magnet Wire
American Insulating Mach'y. Co., Phila., Pa.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY — Measuring Wire & Cable
Watson Machine Co., Paterson, N. J.

MACHINERY—Nail and Tack
Glader, Wm., Machine Works Co., Chicago, Ill.
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Panning
American Insulating Mach'y. Co., Phila., Pa.

MACHINERY—Pointing
Broden Construction Co., Cleveland, O.
H. J. Ruesch Machine Co., Newark, N. J.
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Rod Mill
Broden Construction Co., Cleveland, O.
Morgan Construction Co., Worcester, Mass.
H. J. Ruesch Machine Co., Newark, N. J.
W. A. Schuyler, New York, N. Y.

MACHINERY—Rolling Mill
Broden Construction Co., Cleveland, O.
Morgan Construction Co., Worcester, Mass.
H. J. Ruesch Machine Co., Newark, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Rubber Strip Covering
Watson Machine Co., Paterson, N. J.

MACHINERY—Rubber Tubing and Straining
Royle, John, & Sons., Paterson, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Screw Wire
Sleeper & Hartley, Worcester, Mass.

MACHINERY—Special
American Insulating Mach'y. Co., Phila., Pa.
Broden Construction Co., Cleveland, O.
H. J. Ruesch Machine Co., Newark, N. J.
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY— Special — Combination Machine for Drawing, Cutting-to-length. Straightening and Reeling Bars from Coil in One Operation (Shumag Type)—
W. A. Schuyler, New York, N. Y.

WHERE TO BUY, Continued

MACHINERY—Spooling
American Insulating Mach'y. Co., Phila., Pa.
Fidelity Machine Co., Philadelphia, Pa.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.
Watson Machine Co., Paterson, N. J.

MACHINERY—Spring Making
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Staple
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Straightening
Broden Construction Co., Cleveland, O.
Hallden Machine Co., Thomaston, Conn.
Lewis Machine Co., The, Cleveland, O.
National Machinery Exchange, New York, N. Y.
H. J. Ruesch Machine Co., Newark, N. J.
W. A. Schuyler, New York, N. Y.
F. B. Shuster, New Haven, Conn.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Stranding
Sleeper & Hartley, Inc., Worcester, Mass.
Thomson-Judd Wire Machinery Co., Lynn, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Strip Steel
Broden Construction Co., Cleveland, O.
H. J. Ruesch Machine Co., Newark, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Swaging
H. J. Ruesch Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Taping
American Insulating Mach'y. Co., Phila., Pa.
Fidelity Machine Co., Philadelphia, Pa.
Thomson-Judd Wire Machinery Co., Lynn, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Testing Size of Wire
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Tinsel Rolling Mills
American Insulating Mach'y. Co., Phila., Pa.

MACHINERY—Trolley Wire
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Tube Mill
H. J. Ruesch Machine Co., Newark, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Welding Wire
Eisler Engineering Co., Inc., Newark, N. J.
Micro Products Co., Chicago, Ill.
F. B. Shuster Co., New Haven, Conn.
Thomson-Judd Wire Machinery Co., Lynn, Mass.

MACHINERY—Winding
American Insulating Mach'y. Co., Phila., Pa.
Fidelity Machine Co., Philadelphia, Pa.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Wire Drawing
Aetna-Standard Engineering Co., Youngstown, O.
American Insulating Mach'y. Co., Phila., Pa.
Broden Construction Co., Cleveland, O.
Morgan Construction Co., Worcester, Mass.
H. J. Ruesch Machine Co., Newark, N. J.
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.
W. A. Schuyler, New York, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.
Thomson-Judd Wire Machinery Co., Lynn, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Wire Rope
Thomson-Judd Wire Machinery Co., Lynn, Mass.
Watson Machine Co., Paterson, N. J.

MACHINERY—Wire Tinning
American Insulating Mach'y. Co., Phila., Pa.

MACHINERY—Wrapping Wire
W. A. Schuyler, New York, N. Y.

MILLS—Tandem Rolling and Edging
Torrington Mfg. Co., The, Torrington. Conn.

NICKEL SILVER AND PHOSPHOR BRONZE—Rod, Wire and Strip
Hudson Wire Co., Ossining, N. Y.

OVENS—Brazing
The American Machine & Foundry Co., Crawford Oven Div., New Haven, Conn.

Ovens for All Purposes in the Wire Industry
The American Machine & Foundry Co., Crawford Oven Div., New Haven, Conn.

PAPER—Insulating
E. W. Twitchell, Inc., Phila., Pa.

PATENT ATTORNEYS—
Lancaster, Allwine and Rommel, Washington, D. C.

PICKLING COMPOUNDS
American Chemical Paint Co., Ambler, Pa.

PIPING AND FITTINGS—Acid Resistant
Duriron Co., Inc., The, Dayton, O.
Haveg Corp., Newark, Del.

POTS—Lead Melting
John Robertson Co., Brooklyn, N. Y.

PRESSES—Hydraulic and Mechanical
John Robertson Co., Brooklyn, N. Y.

PRESSES—Lead
John Robertson Co., Brooklyn, N. Y.

PULLERS—Wire
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.

PUMPS—Hydraulic
John Robertson Co., Brooklyn, N. Y.

PYROMETERS—
Leeds & Northrup Co., Philadelphia, Pa.

RECORDERS—
Leeds & Northrup Co,, Philadelphia, Pa.

REEL AND TENSION STAND—
Fidelity Machine Co., Philadelphia, Pa.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

REEL CRUTCHES—
Watson Machine Co., Paterson, N. J.

REELS—Annealing and Stranding
American Pulley Co., Philadelphia, Pa.
Stevens Metal Products Co., Niles, O.

REELS—Steel
Stevens Metal Products Co., Niles, O.

REELS AND SPOOLS—Shipping and Shop
Stevens Metal Products Co., Niles, O.

REFRACTORIES—High Temperature
Norton Co., Worcester, Mass.

ROD BAKERS—
The American Machine & Foundry Co., Crawford Oven Div., New Haven, Conn.

RODS—Wire—Steel
Hudson Wire Co., Ossining, N. Y.
Platt Bros. & Co., The, Waterbury, Conn.

RODS—Wire—Steel
Bethlehem Steel Co., Bethlehem, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
Pittsburgh Steel Co., Pittsburgh, Pa.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

RUST PROOF COMPOUND—
American Lanolin Co., Lawrence, Mass.

SHEET—Steel
Youngstown Sheet & Tube Co., Youngstown, Ohio.

SKIN PROTECTOR—
Magnus Chemical Co., Garwood, N. J.

SOAPS—Industrial and Wire Drawing
Magnus Chemical Co., Garwood, N. J.

SPOOLS—Steel
Stevens Metal Products Co., Niles, O.

STRIP—Brass and Non Ferrous
Hudson Wire Co., Ossining, N. Y.

STRIP—Steel
Bethlehem Steel Co., Bethlehem, Pa.
Firth-Sterling Steel Co., McKeesport, Pa.
Pittsburgh Steel Co., Pittsburgh, Pa.

TANKS—Compound
Watson Machine Co., Paterson, N. J.

TANKS—Pickling
Haveg Corp., Newark, Del.

TREADS—Safety
Norton Co., Worcester, Mass.

TRUCKS—
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

TUBE BENDERS AND FORMERS—
H. J. Ruesch Machine Co., Newark, N. J.

VALVES AND FITTINGS—Acid Proof
Duriron Co., The, Dayton, O.
Haveg Corp., Newark, Del.

VULCANIZERS—
Watson Machine Co., Paterson, N. J.

VULCANIZING PANS—
American Insulating Mach'y. Co., Phila., Pa.

WELDERS—Spot and Butt
Eisler Engineering Co., Newark, N. J.
Micro Products Co., Chicago, Ill.

WIRE—Cold Heading
Bethlehem Steel Co., Bethlehem, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
Pittsburgh Steel Co., Pittsburgh, Pa.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

WIRE—Electric
Hudson Wire Co., Ossining, N. Y.

WIRE—Enameled For Coils
Winsted Div. of Hudson Wire Co., Winsted, Conn.

WIRE—Manufacturers
Bethlehem Steel Co., Bethlehem, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
Pittsburgh Steel Co., Pittsburgh, Pa.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

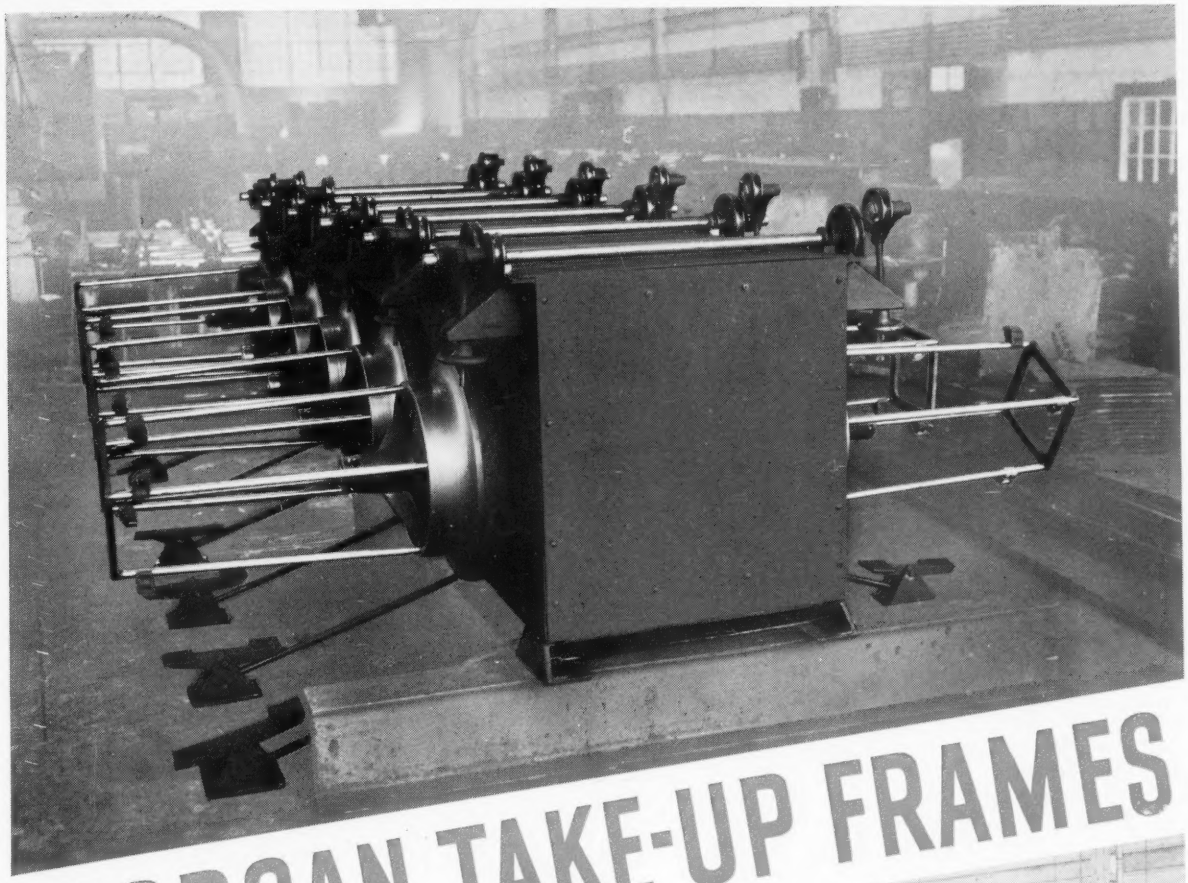
WIRE—Nickel Silver and Phosphor Bronze
Hudson Wire Co., Ossining, N. Y.

WIRE—Non Ferrous to Specification For Special Purposes
Hudson Wire Co., Ossining, N. Y.
Winsted Div. of Hudson Wire Co., Winsted, Conn.

WIRE—Spring
Bethlehem Steel Co., Bethlehem, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
Pittsburgh Steel Co., Pittsburgh, Pa.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

WIRE—Steel—Also Coppered Steel——Also Galvanized Steel
Bethlehem Steel Co., Bethlehem, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
Pittsburgh Steel Co., Pittsburgh, Pa.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

WIRE AND STRIP—Zinc
Metal Industry Works, Poland.
Platt Bros. & Co., The Waterbury, Conn.

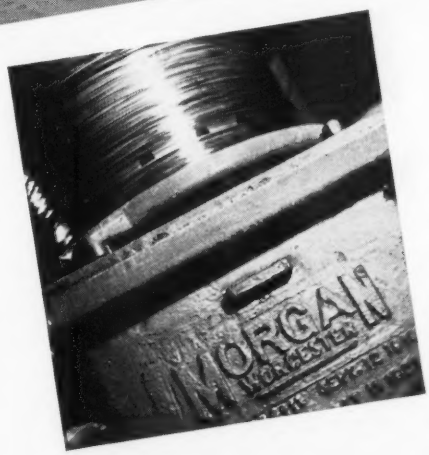


MORGAN TAKE-UP FRAMES

Morgan take-up frames are designed for the long pull. Built to stand up, day after day, under the heavy strain of modern high-speed production. Flexible in design and operation with different sizes and numbers of blocks available — but inflexible in the standards to which they are built.

Typically Morgan-made, which means thoroughness of design, precision construction, strength and dependability —and more profitable operation.

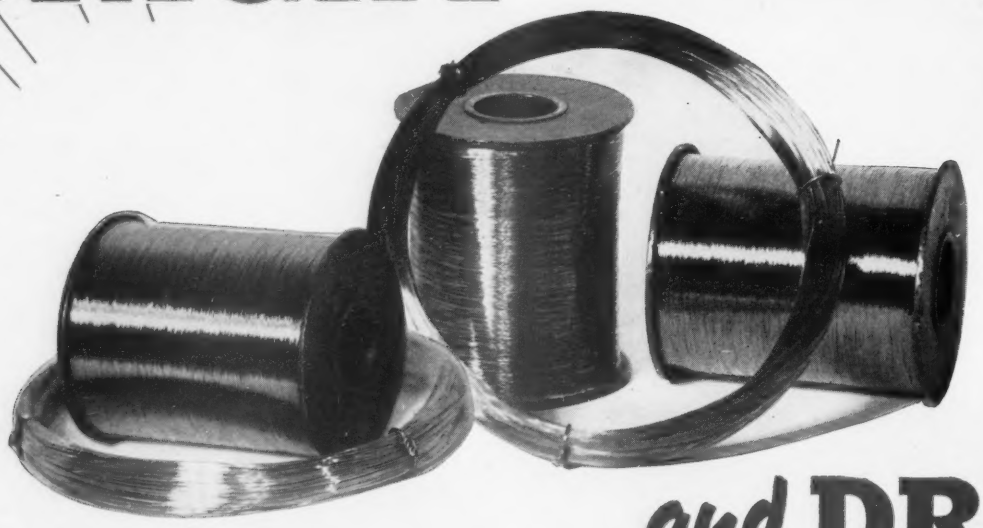
Morgan Construction Co., Worcester, Mass., U. S. A.



Continuous Wire Drawing Machinery

W-33

BRIGHT



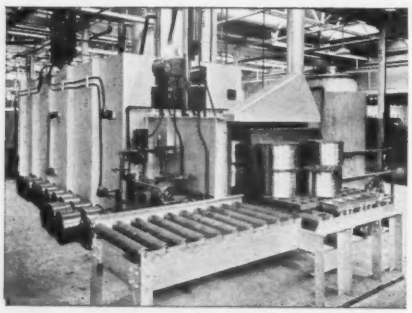
and DRY

From Continuous Special Atmosphere Furnaces

Built by The Electric Furnace Co.

★ Ferrous and non-ferrous wire — from the finest gauges to the heaviest sizes — is bright annealed uniformly and economically in various types of controlled atmosphere furnaces we have built.

Coiled wire, as well as wire on small spools and large reels, is successfully handled in these furnaces. No water seals, steam or vapor of any kind is used, thus staining is entirely eliminated and no drying necessary. The wire is discharged from these furnaces uniformly annealed, absolutely bright and dry, ready for shipping, further processing or fabricating. The installation shown below is one of several types of electric and fuel-fired furnaces we have developed for the wire industry.



A special atmosphere continuous pusher type furnace for bright annealing both heavy and fine copper wire on large reels, on spools and in coils.

Other recent installations include furnaces for bright and clean annealing brass, nickel silver and copper wire; improved pit type furnaces for normalizing rod and bright annealing steel wire in coils, as well as furnaces for scale-free hardening bolts, springs, etc., furnaces for billet heating, bright annealing tubing, strip, stampings; carburizing, copper brazing and other heating and heat treating processes.

If you are interested in improving the quality of your anneal or heat treatment, increasing production or are contemplating any changes or additions to your furnace equipment, our engineers will be glad to work with you. We specialize in building production furnaces to fit the customer's specific requirements — for any heating process — for any product or production.

Ask for our 8-page leaflet showing various types of electric and fuel fired furnaces we have built for the wire industry.

The ELECTRIC FURNACE Co.

ELECTRIC & FUEL FIRED *Furnaces*

SALEM, OHIO